This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Per. 1842. e. 93.

RADCLIFFE LIBRARY
* OXFORD *

RADCLIFFE LIBRARY
OXFORD

A LIST OF ANNIVERSARIES

OF REMARKABLE

ASTRONOMICAL DISCOVERIES AND OCCURRENCES,

DEATHS OF EMINENT ASTRONOMERS,

&c.

COMPILED BY

GEORGE J. WALKER.

> recognosces . . . . . .
> . . . . quo sit merito quæque notata dies.
>
> OVID.

LONDON:
1869.

RADCLIFFE LIBRARY
OXFORD

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

I HOPE this collection of Anniversaries—as full as my limited means of reference have enabled me to make it—may be acceptable to the readers of the "Astronomical Register," notwithstanding its imperfection. With a view to its possible reappearance at some future time, improved and enriched, I shall be glad to receive information and materials from any who are able and willing to furnish them, as also to be corrected where any mistakes may have been made. The blank spaces may be useful for MS. additions, and a leaf could be inserted if more room is required. A passage from the sacred Scriptures, having an astronomical interest, has been prefixed to each month, with the translation revised when needful. This may not be an unsuitable accompaniment to a remembrancer of illustrious names and remarkable phenomena; for the glory is always due to God, and, least of all men, should His word be unwelcome to the astronomer. Eminence in science has, happily, not unseldom been associated with that humble submission to revealed truth which is the highest adornment of intellect, and which should enhance the veneration in which we hold the memory of Copernicus, Kepler, and Newton.

G. J. W.

TEIGNMOUTH, SOUTH DEVON.

JANUARY

Πολυμερῶς καὶ πολυτρόπως πάλαι ὁ Θεὸς λαλήσας τοῖς πατράσιν ἐν τοῖς προφήταις, ἐπ' ἐσχάτων τῶν ἡμερῶν τούτων ἐλάλησεν ἡμῖν ἐν υἱῷ, ὃν ἔθηκεν κληρονόμον πάντων, δι' οὗ καὶ ἐποίησεν τοὺς αἰῶνας, ὃς ὢν ἀπαύγασμα τῆς δόξης καὶ χαρακτὴρ τῆς ὑποστάσεως αὐτοῦ, φέρων τε τὰ πάντα τῷ ῥήματι τῆς δυνάμεως αὐτοῦ, καθαρισμὸν τῶν ἁμαρτιῶν ποιησάμενος, ἐκάθισεν ἐν δεξιᾷ τῆς μεγαλωσύνης ἐν ὑψηλοῖς.

"God, who in many portions and in many ways spake of old unto the fathers in the prophets, at the end of these days spake unto us in (his) Son, whom he appointed Heir of all things, by whom he also made the worlds; who, being the radiance of his glory, and the impress of his substance, and upholding all things by the word of his power, when he had made purification of sins, sat down on the right hand of the Majesty on high."—Heb. i. 1—3.

Days

1. Ceres discovered by Piazzi at Palermo, 1801. John Bernouilli *d.* 1748, *æt.* 81. Julian period, B.C. 4713. Epoch of the Catalogue of Stars of the British Association, 1850. "*Astronomical Register*" commenced, 1863. Mr. S. Gorton, editor.

2.

3. Jeremiah Horrocks *d.* 1641, *æt.* 22.

4. Semele discovered by Tietjen, 1866, in same field with Io.

5.

6.

7. Comet discovered by Miss Herschel, 1790.

8. Satellites of Jupiter discovered by Galileo, 1610. Galileo *d.* 1642, *æt.* 78. The gold medal (2nd) of the Royal Astronomical Society awarded to Prof. Encke, for the *Berlin Ephemeris*, 1830. To Sir John Herschel, for his *Catalogue of Nebulæ*, 1836. To Prof. Bessel (2nd) for the determination of the *Parallax of* 61 *Cygni*, 1841.

9. Carolina L. Herschel *d.* 1848, *æt.* 98. Kepler saw Mars pass over Jupiter, 1591. Fontenelle *d.* 1757, *æt.* 100. The gold medal of the R.A.S. awarded to the Rev. W. Pearson, for his *Introduction to Astronomy*, 1829. To Prof. Bessel (1st), for the *Berlin Star Zones*, 1829. To Prof. Schumacher, for the *Astronomische Nachrichten*, 1829. To G. B. Airy, Esq. (2nd), for the *Reduction of* 80 *Years' Observations of Planets at Greenwich*, 1846. Maria Gaetana Agnesi, *d.* 1799, *æt.* 81.

10. Legendre *d.* 1833, *æt.* 82. Capocci (Naples) *d.* 1864, *æt.* 66. The gold medal of the R.A.S. awarded to M. Jean Plana, for his "*Théorie du mouvement de la Lune*," 1840. To Capt. W. H. Smyth, R.N., for the *Bedford Catalogue*, 1845.

Days

11. 2nd and 4th Satellites of Uranus (as they afterwards proved) first caught sight of by Sir W. Herschel, 1787. The gold medal of the R.A.S. awarded to Sir Thomas Brisbane, for his *Observatory at Paramatta*, 1828. To James Dunlop, for *Observing the Nebulæ of the S. Hemisphere*, 1828. To Prof. Airy (1st), for his researches on the *Inequality of the Earth and Venus*, 1833. To the Honourable J. Wrottesley, for his *Catalogue of* 1,318 *Stars*, 1839.

12. First Meeting of the R.A.S. Sir John Herschel and Mr. Babbage elected members, 1820. Leda discovered by Chacornac, 1856 (discoverer of 6 minor planets). Date of Sir Isaac Newton's preface to the third edition of the Principia, 1725-26, *æt.* 83.

13. Biela's Comet divided into two, seen by Maury, U.S., 1846. Mr. Fox Talbot's paper on Photogenic drawing communicated to the Royal Society, 1839. The gold medal (2nd) of the R.A.S. awarded to Francis Bailey, Esq., for the *repetition of the Cavendish experiment*, 1843. To Prof. Rosenberger, for his *Investigation of the Orbit of Halley's Comet*, 1837.

14. Halley *d.* 1742, *æt.* 86. Aërolite fell, 616, B.C.; broke several chariots and killed 10 men (Chinese Catalogue). The gold medal of the R.A.S. awarded to Baron Damoiseau, for his *Memoirs on the Theory of the Moon*, 1831. To Capt. Kater, for his *Floating Collimator*, 1831. To M. Hansen, for *Researches in Physical Astronomy*, 1842.

15. Biela's Comet divided, seen by Prof. Challis, 1846. Sir John Herschel arrived at the Cape of Good Hope to observe the Southern Heavens, 1834.

16.

17. Most ancient observation of Mars, B.C. 272, near β Scorpii (Almagest).

18.

19. J. E. Bode, *b.* 1747, *d.* Nov. 23, 1826, *æt.* 79.

20. Plana (Turin), *d.* 1864. W. C. Bond (America), *d.* 1859.

21. Comet observed by Regiomontanus, the most splendid of the century, visible in full daylight, 1472.

22. Nemausa discovered by Laurent, 1858.

23.

24.

25.

26. H. Briggs, *d.* 1630, *æt.* 74.

27. Dr. Hutton, *d.* 1823, *æt.* 86.

28. Hevelius, *b.* 1611, *d.* 1687, *æt.* 76.

29.

30.

31.

FEBRUARY.

נֹטֶה שָׁמַיִם לְבַדּוֹ וְדוֹרֵךְ עַל־בָּמֳתֵי־יָם : עֹשֶׂה עָשׁ כְּסִיל וְכִימָה וְחַדְרֵי הֵמָן :

"Who alone spreadeth out the heavens, and treadeth upon the heights of the sea; who maketh Ash,* K'sil,† and Kimah,‡ and the chambers of the south.§"—Job. ix. 8, 9.

Days

1\.

2. O. Gregory *d.* 1841, *æt.* 67. The gold medal (1st) of the R.A.S. awarded to Francis Baily, for the determination of the *Places of* 2,881 *Stars*, 1827. Marquis De l'Hôpital *d.* 1704, *æt.* 43.

3. Bradley appointed Astronomer Royal, 1742. M. Foucault communicates to the Academy of Sciences, Paris, the proof of the rotatory motion of the earth by the displacement of the plane of vibration of the pendulum, 1851. J. B. Biot *d.* 1862, *æt.* 88.

4. Splendid comet seen near the sun, 1106. The gold medal of the R.A.S. awarded to Miss Herschel for her *Reduction of Sir W. Herschel's Observations on Nebulæ*, 1828. La Condamine *d.* 1774, *æt.* 73.

5. C. Clavius, *d.* 1612, *æt.* 75.

6. Peter the Great of Russia visited Greenwich Observatory, 1698. Europa discovered by Goldschmidt, 1858 (discoverer of 14 minor planets).

7. The gold medal of the R.A.S. awarded to MM. Herschel and South, for their *Researches on Multiple Stars*, 1826.

8. Lætitia discovered by Chacornac, 1856. The gold medal of the R.A.S. awarded to Messrs. Miller and Huggins, for their work in the *Spectrum Analysis of Celestial Bodies*, 1867. To M. Otto Struve, for his determination of the *Constant of Precession*, 1850. To Robert Grant, Esq., for his *History of Physical Astronomy*, 1856. To M. Hermann Goldschmidt, for the *Discovery of* 13 *Minor Planets*, 1861.

9. Maskelyne, *d.* 1811, *æt.* 78. He suggested and produced the first "Nautical Almanac," 1767. He superintended its publication 48 years. Capt. J. M. Gilliss, Director of the Naval Observatory, Washington, *d.* 1865. The gold medal of the R.A.S. awarded to William Lassell, Esq., for his *Equatorial Instrument*, 1849. To the Rev. W. R. Dawes, for his *Astronomical Labours*, 1855. To Prof. Adams, for his *Contributions to the Lunar Theory*, 1866.

10. Ausonia discovered by De Gasparis, 1861 (discoverer of 9 minor planets). Sir David Brewster *d.* 1868, *æt.* 86. The gold medal of the R.A.S. awarded to Prof. Struve, for his *Researches on Multiple Stars*, 1826. To M. Charles Rumker, for his catalogue of 12,000 stars, 1854. To Prof. Hansen, for his *Lunar Tables*, 1860. To Prof. G. P. Bond, for his *work on Donati's Comet*, 1865.

11. Descartes *d.* 1650, *æt.* 54. Sir W. Herschel announces the discovery of the 2nd and 4th satellites of Uranus to the Royal Society, 1787. The gold medal of the R.A.S. awarded to J. R. Hind,

---

* The Great Bear.

† Orion.

‡ The Pleiades.

§ *i.e.* The Southern Heavens.

Days

Esq., for the *discovery of* 8 *minor planets*, 1853. To R. C. Carrington, Esq., for the *Red Hill Catalogue of* 3,735 *circumpolar stars*, 1859. J. A. Maginus *d.* 1617, *æt.* 62.

12. Kant *d.* 1804, *æt.* 80. Gold medal of the R.A.S. awarded to Mr. Stone (First Assistant at Greenwich Observatory), for his *Researches on the Solar Parallax*, &c. 1869. The gold medal of the R.A.S. awarded to the Rev. R. Main, for his *Contributions to the Memoirs*, 1858.

13. Boscovich *d.* 1787, *æt.* 76. Mrs. Mary Somerville elected an Honorary Member of the R.A.S., 1835. The gold medal of the R.A.S. awarded to Dr. C. A. F. Peters, for his *Papers on the Parallax of Stars*, 1852. To M. Schwabe, for his discovery of the *Periodicity of the Sun Spots*, 1857. To Prof. Argelander, for his *Survey of the Northern Heavens*, 1863.

14. The gold medal of the R.A.S. awarded to Warren De La Rue, Esq., for his labours in *Celestial Photography*, 1862. To M. Le Verrier, for his *Solar and Planetary Tables*, 1867.

15. Hadley *d.* 1744. W. R. Dawes *d.* 1868, *æt.* 69. Reign of the Emperor Akbar commenced, 1556. He encouraged astronomy.

16. Bird's celebrated Greenwich Quadrant mounted, 1750. Stoffler *d.* 1531, *æt.* 79.

17. Prof. G. P. Bond, U.S., *d.* 1865. Clotho discovered by Tempel, 1868 (discoverer of 5 minor planets). Ægle discovered by Coggia (Marseilles), 1868.

18. Baron von Biela *d.* 1856, *æt.* 74 (discoverer of the comet called after him). Annular eclipse of the sun observed by Maclaurin, 1737.

19. Rheinhold *d.* 1553, *æt.* 42 (Prutenic Tables). Meteoric stone of 10 lbs. fell in Portugal, 1796.

20. Tobias Mayer *d.* 1762, *æt.* 39. Borda *d.* 1799, *æt.* 66. De Mairan *d.* 1771, *æt.* 93.

21. Occultation of Saturn by the moon, observed by Thius, at Athens, A.D. 503.

22.

23. Gauss *d.* 1855, *æt.* 78. Malus *d.* 1812, *æt.* 37.

24. Cavendish *d.* 1810, *æt.* 78.

25. Total eclipse of the sun, visible in the British Isles, 1598; day long remembered as *Black Saturday*. Sir Christopher Wren *d.* 1723, *æt.* 90; he built Greenwich Observatory. Fine comet discovered by De Vico, 1845. Dr. Lee, of Hartwell House, Bucks, *d.* 1866, *æt.* 82.

26. Era of Nabonassar, B.C. 747. Periodic comet discovered by Brorsen, 1846. W. Kitchiner (on Telescopes), *d.* 1827, *æt.* 52.

27. Periodic comet discovered by Biela, 1826. Perihelion passage of a magnificent comet, which passed nearer the sun (within one-seventh part of the sun's radius) than any other on record, 1843, accomplishing a semi-revolution round the sun in 2 hours.

28. The same seen with the naked eye, near the sun, by many persons in Italy, the Cape of Good Hope, and America, 1843. W. J. Sgravesande *d.* 1742, *æt.* 54, the first who publicly taught the philosophy of Newton on the Continent. Comet of 1556 (Charles V.) discovered.

29.

MARCH.

הַשָּׁמַיִם מְסַפְּרִים כְּבוֹד־אֵל וּמַעֲשֵׂה יָדָיו מַגִּיד הָרָקִיעַ : יוֹם לְיוֹם יַבִּיעַ אֹמֶר
וְלַיְלָה לְּלַיְלָה יְחַוֶּה־דָּעַת : אֵין־אֹמֶר וְאֵין דְּבָרִים בְּלִי נִשְׁמָע קוֹלָם : בְּכָל־הָאָרֶץ
יָצָא קַוָּם וּבִקְצֵה תֵבֵל מִלֵּיהֶם :

"The heavens declare the glory of God, and the firmament showeth forth the work of his hands. Day unto day poureth forth speech, and night unto night showeth knowledge. (There is) no speech nor words (where) their voice is not heard. Their sound* is gone out through all the earth, and their words to the end of the world.—Ps. xix. 1—4.

Days

1. Most ancient observation of Saturn, near γ Virginis, B.C. 228 (Almagest). Eclipse of the moon, 1504, of much service to Columbus. Bellona discovered by Luther, 1854 (discoverer of 16 minor planets). Amphitrite discovered by Marth, 1854; by Pogson on the 2nd, and by Chacornac on the 3rd (three separate discoverers). Peter Barlow *d.* 1862, *æt.* 86.
2. F. Bianchini *d.* 1729, *æt.* 67. Olbers, *d.* 1840, *æt.* 82. The Czar Nicholas I. of Russia *d.* 1855; erected the observatory of Pulkova. R. Dunthorne *d.* 1775.
3. Robert Hooke *d.* 1702, *æt.* 67.
4. Donati's Comet last seen at the Cape of Good Hope by Sir Thomas Maclear, 1859. Angelina discovered by Tempel, 1861 (discoverer of 5 minor planets). Date of the Warrant of Charles II. for the payment of 100*l.* a-year to Flamsteed, as Astronomer Royal, 1674-5.
5. Sir John Herschel began his observations of the Southern Heavens at the Cape, 1834.
6. First number of the "Philosophical Transactions" appeared, 1665. Beautiful Photographs of the Moon by Rutherford (America), 1865.
7. F. W. Bessel *d.* 1846, *æt.* 62.
8. Partial eclipse of the moon, observed by the Chaldeans B.C. 719 (Ptolemy). Peter the Great makes an observation of Venus with the mural quadrant at Greenwich Observatory, 1698. Pons's periodic comet of 1819 detected by Winnecke, 1858. Cybele discovered by Tempel, 1861.
9. C. F. Kirch *d.* 1740.
10.
11. Le Verrier *b.* 1811.
12. Meteoric stone of 20lbs. fell at Sules, near Ville Franche, 1798. R. Murphy *d.* 1843, *æt.* 37.
13. Uranus discovered by Sir W. Herschel, 1781. Meteorolite of 160lbs. fell in the government of Smolensko, 1807. Perihelion passage of Halley's comet, 1759.
14.
15. Spot on the Sun observed by Tobias Mayer, diam. $\frac{1}{20}$ of that of the Sun (nearly 43,000 miles), 1758. Annular eclipse of the Sun,

---

* Heb. *chord* or *string*, i.e. musical chord.

Days

1858, observed in England; appearance of a solar spot 107,520 miles in breadth the same day. Diana discovered by Luther, 1863.

16. N. Bowditch, translator and commentator of the Méchanique Céleste, *d.* 1838, at Boston, *æt.* 65. S. P. Rigaud *d.* 1839, *æt.* 65.

17. Venus, Jupiter, Mars, and Mercury in the same field of the telescope, 1725. Adelmus, a Benedictine monk, mentions a black spot seen on the sun, 807. Daniel Bernouilli *d.* 1782, *æt.* 82 (8 members of this family more or less celebrated as mathematicians). Psyche discovered by De Gasparis, 1852.

18. Colebrooke *d.* 1837, *æt.* 72.

19. Earliest observation of a lunar eclipse by the Chaldeans, 720 B.C.; total at Babylon (Ptolemy).

20. NEWTON *d.* 1727, *æt.* 85. Total eclipse of the sun, 1140 (William of Malmesbury).

21. La Caille *d.* 1762, *æt.* 49. Large meteor observed by Petit, and inferred by him to be a satellite to the earth, 1846.

22. A barn in a village of Haute-Garonne set on fire by a meteor, and destroyed with the stables and beasts, 1846, 3 P.M.

23.

24. John Harrison, inventor of the marine chronometer, *d.* 1776, *æt.* 83. Concordia discovered by Luther, 1860.

25. Titan discovered by Huyghens, 1655. Spot seen as a notch on the edge of the sun's disc, by Newall, 1850.

26. Supposed planet Vulcan, seen by Lescarbault passing across the sun, 1859. Great comet observed by M. Flaugergues, 1811.

27.

28. Condorcet *d.* 1794. Pallas discovered by Olbers, 1802. Tail of the great comet of 1843 found to be 150,000,000 miles in length (breadth, 3,300,000).

29. Vesta discovered by Olbers, 1807. First stone of Lord Wrottesley's observatory, near Wrottesley Hall, laid, 1842.

30. Comet visible at noon (Hind), 1847. J. Narrien, *d.* 1859, *æt.* 77.

31. John Bird, celebrated mathematical instrument maker, *d.* 1776, *æt.* 67. Harmonia discovered by Luther, 1856.

APRIL.

—γνωρίσας ἡμῖν τὸ μυστήριον τοῦ θελήματος αὐτοῦ, κατὰ τὴν εὐδοκίαν αὐτοῦ, ἣν προέθετο ἐν αὐτῷ, εἰς οἰκονομίαν τοῦ πληρώματος τῶν καιρῶν, ἀνακεφαλαιώσασθαι τὰ πάντα ἐν τῷ Χριστῷ, τὰ ἐπὶ τοῖς οὐρανοῖς, καὶ τὰ ἐπὶ τῆς γῆς.

"Having made known unto us the mystery of his will, according to his good pleasure, which he purposed in himself, for the dispensation of the fulness of times, to gather together in one all things in Christ, the things in the heavens, and the things on the earth.—Eph. i. 9, 10.

1. Hugh Breen *d.* 1848, having just completed the reduction of the Greenwich Lunar Observations.

Days

2. Splendid comet, 1066, regarded in England as a presage of the success of the Norman invasion.
3. Napier of Merchistoun *d.* 1617, *æt.* 67.
4. Occultation of Mars by the moon, mentioned by Aristotle, 357 B.C. (Kepler.) Remarkable display of shooting stars in England and France, 1095. Lalande *d.* 1807, *æt.* 75. Calypso discovered by Luther, 1858.
5. Mass of meteoric iron, 70 cubic feet, fell in America, 1800. Themis discovered by De Gasparis, 1853.
6. Shower of sand for 15 hours in the Atlantic, 1719. Phocea discovered by Chacornac, 1853. Circe discovered by the same, 1855.
7. Clytie discovered by Tuttle, 1862.
8. G. Purbach *d.* 1461, *æt.* 38 (began to translate the Almagest). Arbogast *d.* 1803, *æt.* 44.
9. Lord Bacon *d.* 1626, *æt.* 66. H. Pemberton, *d.* 1771, *æt.* 77. Maia discovered by Tuttle, 1861. J. C. Wolff d. 1754, *æt.* 76.
10. Lagrange *d.* 1813, *æt.* 77. G. B. Amici *d.* 1863, *æt.* 77.
11.
12. Hygeia discovered by De Gasparis, 1849.
13.
14. Hell *d.* 1792, *æt.* 72; observed transit of Venus, June 3, 1769, in Lapland.
15. Ariadne discovered by Pogson, 1857. Fall of an aerolite at Kaba-debreczin, Hungary, containing a small quantity of *organic matter*, 1857. P. Horrebow *d.* 1764, *æt.* 85.
16. James Cassini *d.* 1756, *æt.* 79. A. G. Cassini, 5th of the name, *d.* 1832. The members of this family occupied the Paris Observatory for 122 years.
17. Mass of meteoric iron fell at Jalindher (India) 1620; out of it, mixed with common iron, were made two sabres, a knife, and a dagger (Memoirs of Jehanghir). Thetis discovered by Luther, 1852. Asia discovered by Pogson, 1861. General Mudge (Trigon, survey) *d.* 1821, *æt.* 59.
18. Comet discovered by Miss Herschel, 1790. Ianthe discovered by Peters, 1868 (discoverer of 8 minor planets).
19. Leucothea discovered by Luther, 1855. Nicholas Saunderson *d.* 1739, *æt.* 57. Large solar spot (visible to naked eye) observed by Sir W. Herschel, 1779.
20.
21. Le Lahire *d.* 1719, *æt.* 79. Spot on Venus discovered by J. D. Cassini, by which he determined the period of its rotation, 1667.
22. Building of Rome (Varronian epoch), B.C. 753. The Royal Society Incorporated by Charter (second time), 1663. (Chas. II.)
23.
24.
25. Poisson *d.* 1840, *æt.* 59. Metis discovered by Graham, 1848.
26. Extensive fall of meteoric stones near L'Aigle, Normandy, 1803; nearly 3,000 collected. Capt. Kater *d.* 1835, *æt.* 58. Beatrix discovered by De Gasparis, 1865.

Day
27.
28. New star of 5th magnitude seen by Hind in Ophiuchus, 1848. It is now 11th or 12th magnitude. W. Wallace *d.* 1843, *æt.* 75.
29. Hesperia discovered by Schiaparelli, 1861. Leto discovered by Luther, 1861. Dionysius Lardner *d.* 1859, *æt.* 66.
30.

MAY.

Πᾶσα δόσις ἀγαθὴ καὶ πᾶν δώρημα τέλειον ἄνωθέν ἐστιν, καταβαῖνον ἀπὸ τοῦ Πατρὸς τῶν φώτων, παρ' ᾧ οὐκ ἔνι παραλλαγὴ ἢ τροπῆς ἀποσκίασμα.

"Every good gift, and every perfect gift descendeth from above, from the Father of the lights,* with whom there is no variableness, or shadow of turning."—Jas. i. 17.

1. Pingré *d.* 1796, *æt.* 85. Remarkable fall of meteoric stones in Guernsey County, Ohio, U.S., 1860.
2. Sappho discovered by Pogson, 1864. Total eclipse of the sun, visible in the north of Europe, 1733.
3. Third recorded transit of Mercury, observed by Hevelius, 1661. Last total eclipse of the sun visible at London, 1715 (the one previous, 20th March, 1140). Leonard Ximenes *d.* 1786, *æt.* 70.
4. Isaac Barrow *d.* 1677, *æt.* 47.
5. Laplace *d.* 1827, *æt.* 78 (his last words, "*Ce que nous connaissons est peu de chose; ce que nous ignorons est immense*"). Proserpine discovered by Luther, 1853. Panopea discovered by Goldschmidt, 1861 (discoverer of 13 minor planets).
6. Humboldt *d.* 1859, *æt.* 90.
7.
8. Date of Sir Isaac Newton's Preface to the first edition of the Principia, 1686.
9.
10. Neptune observed as a star by Lalande, 1795. Dr. Thomas Young *d.* 1829, *æt.* 56.
11. Parthenope discovered by De Gasparis, 1850.
12. Earliest recorded account of the "red flames" in a solar eclipse, by Captain Stannyan, Berne, 1706, and of the eclipse shadow being seen, by Duiller. Variable star in Corona Borealis, 1866. Thomas Lowndes (founder of Astronomical Professorship), *d.* 1748, *æt.* 68
13. One of the most magnificent comets on record discovered by Mr. J. Tebbutt, New South Wales, 1861 (first seen in England June 29th).
14. Thomas Simpson, *d.* 1761, *æt.* 51. Fall of an aerolite containing *organic matter*, in the South of France, 1864.
15. Kepler verifies his third law, 1618. Shower of meteoric stones fell in France, 1864.
16. First observation made with the Greenwich altazimuth, 1847.
17. Mercury occulted by Venus, 1737. Clairaut *d.* 1765, *æt.* 52.

---

* i.e., the lights of heaven—the heavenly bodies.

Days

Shadow of Titan on Saturn seen by Dawes and others, 1862. Sylvia discovered by Pogson, 1866.

18. Wargentin observes the moon to disappear completely in a lunar eclipse, 1761.

19. Total eclipse of the sun, Larissa (Xenophon, Anabasis), B.C. 556 (Airy). Irene discovered by Hind, 1851, and by De Gasparis, on the 23rd.

20. Emerson *d.* 1782, *æt.* 81.

21.

22. Total eclipse of the sun at Paris, 1724. Shower of 200 stones fell at Stennem, between Vienna and Prague, 1812. Daphne discovered by Goldschmidt, 1856.

23. Copernicus *d.* 1543, *æt.* 70 (according to others on 24th): the epitaph on his monument in the *Johanneskirche* in Thorn, written by himself:—

Non parem Pauli gratiam requiro,
Veniam Petri non posco, sed quam
In crucis ligno dederas latroni
Sedulus oro.

Isis discovered by Pogson, 1856 (discoverer of 6 minor planets). Niépce de Saint-Victor presents to the Academy of Sciences, Paris, his first paper on heliographic engraving, 1853.

24. Solar spot seen by Pastorff, having an area about four times the entire surface of the earth, 1828.

25. R. Gemma (*Frisius*) *d.* 1555, *æt.* 47.

26. Fall of two masses of meteoric iron in Agram, Croatia, 1751.

27. Nysa discovered by Goldschmidt, 1857.

28. Eclipse of the sun, predicted by Thales, B.C. 584, Herodotus (Airy). Nebula in Scorpio, 80 Messier, discovered to be variable by Pogson, 1860.

29. Apparition of Halley's comet, 1456; on account of this comet the Pope, Calixtus III., ordered the church bells to be rung daily at noon (a custom which still exists in Romish countries), and extra *Ave Marias* to be repeated by everybody. Feronia discovered by Peters, 1861. 99th minor planet discovered at Marseilles by Borrelli, 1868.

30. Epoch of the Alfonsine Tables, 1252.

31. Dr. Chalmers *d.* 1847, *æt.* 67 ("Astronomical Discourses," 1816). P. C. Lemonnier *d.* 1799, *æt.* 84.

JUNE.

Πίστει νοοῦμεν κατηρτίσθαι τοὺς αἰῶνας ῥήματι Θεοῦ, εἰς τὸ μὴ ἐκ φαινομένων τὸ βλεπόμενον γεγονέναι.

"By faith we understand that the worlds were framed by the word of God, so that that which is seen was not made out of things which do appear."—Heb. xi. 3.

1. Second memoir on the perturbations of Uranus, by Le Verrier, "Comptes Rendus," 1846.

Days

2. Prof. G. B. Donati discovered the comet which is called after him, 1858.
3. Wales, Astronomer to Cook, observed the transit of Venus at Hudson's Bay, 1769. Capt. Cook observed it at Tahiti.
4.
5. Transit of Venus, 1761. R. Cotes *d.* 1716, *æt.* 34.
6.
7. Fraunhofer *d.* 1826, *æt.* 40. He made the great Dorpat telescope.
8. Huyghens *d.* 1695, *æt.* 66.
9. Mercury observed by the Chinese, near Præsepe in Cancer, A D. 118. Pascal *b.* 1623, *d.* 1662, *æt.* 39 Aerolite of 6 cwt. and nearly 1,000 lesser stones fell at Kuyahinza, in Hungary, 1866.
10. Complete disappearance of the moon in a total eclipse, 1816.
11. Professor Baden Powell *d.* 1860, *æt.* 64.
12. Periodic comet discovered by Pons, 1819. Re-discovered by Winnecke at Bonn, March 8th, 1858. Edwd. Troughton *d.* 1835, *æt.* 82. Messrs. Wheatstone and Cooke's first patent for the electric telegraph, 1837.
13. Earliest publication about the solar spots, by J. Fabricius (Dedication) 1611. They were seen by Galileo, about the same time. Comet (II) discovered by Winnecke, 1868; Mr. Huggins found its spectrum closely agreeing with that of carbon. The gold medal (1st) of the R.A.S. awarded to Prof. Encke, for his *investigation of the Orbit of the Comet which bears his Name*, 1823. To C. Babbage, Esq., for his *Computing Engine*, 1823. (This was the first gold medal awarded by the Society.)
14. Maclaurin *d.* 1746, *æt.* 48 Lexell's Comet discovered by Messier, 1770. George Bishop *d.* 1861.
15. Meteoric stone of 203 lbs. fell at Juvénas, Ardéche, 1821. Thisbe discovered by Peters, 1866.
16. Remarkable fall of meteorolites at Sienna, 1794.
17. Meteorolite weighing 6 oz. fell at sea, on board an American ship, lat. 31° N. long. 70° W., 1809. Total eclipse of the sun visible in Scotland, 1433, long remembered as the *Black Hour.*
18.
19.
20. New star not far from β Cygni, discovered by the Carthusian monk Anthelme, 1670. Sir John W. Lubbock *d.* 1865, *æt.* 62.
21. Wheatstone describes the stereoscope in a communication to the Royal Society, 1838. J. C. Burckhardt *d.* 1825, *æt.* 52.
22. Abjuration of Galileo before the Inquisition, 1633 ("e pur si muove.")
23.
24. Melpomene discovered by Hind, 1852.
25. The Bureau des Longitudes, Paris, instituted, 1795.
26. D. Rittenhouse *d.* 1796, *æt.* 64. Comet seen in transit over the sun (Pastorff), 1819.
27. Periodic comet discovered by D'Arrest, at Leipsic, 1851.
28. Era of the Callippic cycle, B.C. 330. Eugenia discovered by Goldschmidt, 1857. Date of the will of Robert Recorde (his death soon after), 1558. The first mathematician of his day; he intro-

duced analytical science, and (probably) the Copernican system into this country.

29. Great comet suddenly visible in England, 1861.
30. The earth, supposed by Mr. Hind to have passed through the tail of the great comet of 1861.

JULY.

—ὅτι ἐν αὐτῷ ἐκτίσθη τὰ πάντα, τὰ ἐν τοῖς οὐρανοῖς καὶ τὰ ἐπὶ τῆς γῆς, τὰ ὁρατὰ καὶ τὰ ἀόρατα, εἴτε θρόνοι, εἴτε κυριότητες, εἴτε ἀρχαὶ, εἴτε ἐξουσίαι· τὰ πάντα δι' αὐτοῦ καὶ εἰς αὐτὸν ἔκτισται· καὶ αὐτὸς ἐστὶν πρὸ πάντων, καὶ τὰ πάντα ἐν αὐτῷ συνέστηκεν.

"For in him* were all things created, things in the heavens and things on the earth, things visible and things invisible, whether thrones, or dominions, or principalities, or powers; all things have been created by him, and for him: and he is before all things, and in him all things consist."—Col. i. 16, 17.

1. Mean epoch of the Olympiads, B.C. 776. Lexell's comet approached within 1,400,000 miles of the earth, 1770 (nearer than any other on record). General Roy *d.* 1790. Large comet discovered in several parts of Europe, from 1st to 2nd, 1819. Hebe discovered by Hencke, 1847.
2. W. Gascoygne *d.* 1644, *æt.* 23; invented the micrometer (about 1641). Tail of the great comet of 1843 observed above 100° long.
3. Foundation stone of the observatory of Pulkova laid, 1835. Shower of stones in Plaun, Bohemia, 1753. Antonio Ulloa *d.* 1795, *æt.* 79.
4.
5. Date of the "Imprimatur" of S. Pepys, President of the Royal Society, in the first edition of Newton's Principia, 1686.
6. Regiomontanus (Johann Müller) *d.* 1476. *æt.* 41; he printed the first almanac.
7. Christian IV. of Denmark laid with his own hand the first stone of the new observatory of Copenhagen, 1637.
8. Total eclipse of the sun, 1842, excited great interest in the south of France and Italy. Undina discovered by Peters, 1867.
9. Picard began his observations at the R. Observatory, Paris, 1673; he commenced the "Connaissance des Temps" in 1679.
10. Flamsteed removed to the R. Observatory, Greenwich, 1676.
11. Hecate, the 100th minor planet, discovered by Watson, 1868; also by Coggia at Marseilles, on the 16th. J. N. Delisle *d.* 1768, *æt.* 80.
12. Picard *d.* 1682 (Delambre), *æt.* 53. Daguerre *d.* 1851, *æt.* 62; exhibited his sun pictures, Jan. 1839.
13. J. Bradley *d.* 1762, *æt.* 70. John Bernouilli III. *d.* 1807, *æt.* 63.
14. Comet of 1264, one of the grandest on record, discovered. Fall of an aerolite from a large meteor at Brannau, 1846. Professor Piazzi Smyth ascended the Peak of Teneriffe for astronomical and other observations, 1856.

---

* i.e., the Son of God.

Days

15. Epoch of Metonic Cycle, B.C. 432. Royal Society incorporated by Royal Charter, 1662—Lord Brouncker, President.

16. Era of the Hejra, A.D. 622. About 12 meteoric stones fell at Sienna, Tuscany, 1794.

17.

18. Robert Hooke *b.* 1635, *d.* in 1702; Abraham Sharp (optician) *d.* 1742, *æt.* 91. Total eclipse of the sun, to observe which Professor Airy and many other astronomers went to Spain, 1860. Excellent photographs of its various phenomena taken by M. De la Rue. C. Scheiner *d.* 1650, *æt.* 75.

19. Comet seen during a total eclipse of the sun, 418. Great fire-ball described by Halley, and pronounced by him to be a cosmical phenomenon, 1686. John Playfair *d.* 1819, *æt.* 71.

20. Solar spots observed by Hevelius, covering a third part of the sun's disc, 1643.

21. Maurolico *d.* 1575, *æt.* 81. Venus and Jupiter, at 3¾ A.M., only 13″ apart, 1859. Thomas Harriot *d.* 1621, *æt.* 61.

22. Piazzi *d.* 1826, *æt.* 80. Urania discovered by Hind, 1854.

23.

24. Extensive shower of stones near Agen (France), 1790.

25. Apparition of Halley's comet, Europe, 1531; China and Japan on 13th inst. G. Kirch *d.* 1710, *æt.* 71.

26.

27. Maupertuis *d.* 1759, *æt.* 61.

28. Monge *d.* 1818, *æt.* 72. Total eclipse of the sun observed in Sweden by Professor Airy, Mr. Hind, and others, 1851.

29. B. Robins *d.* 1751, *æt.* 44. Eunomia discovered by De Gasparis, 1851. Spot on the sun delineated by Nasmyth, showing the "willow-leaf" structure, 1860. G. De Prony *d.* 1839, *æt.* 84.

30.

31. Comet of greatest known perihelion distance (4.04) discovered by Sarabat, 1729. General Roy commences the triangulation for connecting the observatories of Paris and Greenwich, with Ramsden's great theodolite, 1787.

AUGUST.

שְׂאוּ־מָרוֹם עֵינֵיכֶם וּרְאוּ מִי־בָרָא אֵלֶּה הַמּוֹצִיא בְמִסְפָּר צְבָאָם לְכֻלָּם בְּשֵׁם
יִקְרָא מֵרֹב אוֹנִים וְאַמִּיץ כֹּחַ אִישׁ לֹא נֶעְדָּר׃

"Lift up your eyes on high, and behold who hath created these (things); who bringeth out their host by number: he calleth them all by name; by the greatness of (his) might, and the strength of (his) power; not one is missing." Isa. xl. 26.

1. Miss Caroline Herschel discovered a comet, 1786; 6 others discovered at various times by the same lady.

2. Total eclipse of the sun mentioned by William of Malmesbury, 1133. Carnot *d.* 1823, *æt.* 70.

Days

3. Total eclipse of the sun mentioned by Thucydides, 430 B.C.; the stars seen.
4. R. Sheepshanks *d.* 1855, *æt.* 61.
5. Halley's comet first seen by MM. Dumouchel and De Vico, at Rome, 1835.
6. Julia discovered by Stephan, 1866. A. Cagnoli *d.* 1826, *æt.* 73.
7.
8. Great comet (which Napoleon I. looked upon as his protecting *génie*) discovered by Messier, 1769 (discoverer of 13 comets whose orbits have been computed). 255 transits *on the same day* taken by Bradley and his nephew at Greenwich, 1743.
9. Periodical shower of meteors, "Fiery tears of St. Lawrence," 9th—11th.
10. Foundation of the Royal Observatory, Greenwich, laid 1675. Madame la Marquise du Châstelet, translator of the Principia into French, *d.* 1749, *æt.* 43.
11.
12.
13. First stone of Uraniberg, Tycho Brahé's Observatory, laid, 1576; variable star Mira Ceti, first seen by D. Fabricius, 1596; Iris discovered by Hind, 1847.
14. Total eclipse of the sun (eclipse of Agathocles, *Diod. Sic.*), B.C. 309.
15. P. Bouguer *d.* 1758, *æt.* 60. Edward Waring *d.* 1798, *æt.* 62.
16. James Bernouilli I. *d.* 1705, *æt.* 51. Hestia discovered by Pogson, 1857; Helena discovered by Watson, 1868.
17. Great comet of 1811, last seen in Siberia by Wisniewski, a Russian astronomer. 1812.
18. Great meteor traversed the whole of Europe, from the North Sea to Rome; altitude 50 miles, not less than 4,000 feet in diameter, velocity 20 to 40 miles a second—1783. Total eclipse of the sun, 1868; observed in India by Major Tennant (sent out on purpose) and Lieutenant Herschel. The rose-coloured prominences definitely determined to consist of gaseous matter in a state of ignition.
19. Delambre *d.* 1822, *æt.* 72. Enceladus discovered by Sir W. Herschel, 1787. James Nasmyth *b.* 1808. Observatory of Pulkova finished (cost £100,000, and £10,000 allotted for its annual maintenance), 1839.
20. Immense spot on the centre of the sun's disc, seen by Galileo and others, with the naked eye at sunset, 19th, 20th, and 21st inst., 1612.
21. A. L. Cauchy *b.* 1789. Jupiter seen (apparently) without his satellites, 1867.
22. Whiston *d.* 1752, *æt.* 85. Periodic comet discovered by De Vico, 1844. Fortuna discovered by Hind, 1852. Miriam discovered by Peters, 1868. (12 minor planets discovered in 1868—a greater number than in any previous year. In 1861, 10 discovered.)
23. Sir William Herschel *d.* 1822, *æt.* 84. "*Cœlorum perrupit claustra*" (in the inscription on his monument at Upton).
24. Minor planet (93) discovered by Watson, 1867.

Days

25. J. Arnold, *d.* 1799, *æt.* 55; one of the greatest improvers of the marine chronometer. Clio discovered by Luther, 1865.
26. Encke *d.* 1865, *æt.* 74. Halley's comet, at its apparition in 1682, observed by Hevelius, Cassini, Picard, and La Hire.
27. Total eclipse of the moon, disastrous to the Athenians at Syracuse, under Nicias, 412 B.C. Sir Jonas Moore *d.* 1679, *æt.* 62.
28. Herschel's great telescope completed, 1789. Discovery of the 6th satellite of Saturn confirmed.
29. H. Goldschmidt *d.* 1866, *æt.* 64 (discoverer of 13 minor planets). Mr. Huggins detected the gaseous nature of the planetary nebula, 37, H iv. Draconis, 1864. J. Sniadecki *b.* 1756, *d.* in 1830. F. Carlini *d.* 1862, *æt.* 77.
30. Francis Baily *d.* 1844, *æt.* 70. Galatea discovered by Tempel, 1862. Solar spot observed by Capt. Davis, 1839. 186,000 miles long; surface, 25,000,000,000 square miles.
31. Neptune's orbit determined by Le Verrier (*Comptes Rendus*), 1846 (its elements given, but not published, by Adams, in October 1845).

SEPTEMBER.

כִּי־אֶרְאֶה שָׁמֶיךָ מַעֲשֵׂה אֶצְבְּעֹתֶיךָ יָרֵחַ וְכוֹכָבִים אֲשֶׁר כּוֹנָנְתָּה : מָה־אֱנוֹשׁ
כִּי־תִזְכְּרֶנּוּ וּבֶן־אָדָם כִּי תִפְקְדֶנּוּ :

"When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast established; what is man, that thou rememberest him? and the son of man, that thou visitest him?"—Psalm viii. 3, 4.

1. Partial eclipse of the moon observed by the Chaldeans at Babylon, 719 B.C. (Ptolemy). Dr. Keill *d.* 1721, *æt.* 50. Euphrosyne discovered by Ferguson, 1854. Sudden outburst of intense light on the sun, seen by MM. Carrington and Hodgson; patches of light, visible for five minutes, traversed a space of 33,700 miles, simultaneously with magnetic disturbance, 1859.
2. Juno discovered by Harding, 1804. Baron von Zach, *d.* 1832, *æt.* 78. Sir W. R. Hamilton (Astronomer Royal of Ireland) *d.* 1865, *æt.* 60.
3. Most ancient observation of Jupiter, seen to eclipse δ Cancri, B.C. 240 (Almagest).
4. C. F. Cassini *d.* 1784, *æt.* 70. Janssen (1868, Hindostan) enabled to confirm his observations of Aug. 19th, on the solar luminous prominences, and finds them formed of incandescent hydrogen.
5.
6. Minor planet (94) discovered by Watson.
7. Pond *d.* 1836, *æt.* 69. Euler *d.* 1783, *æt.* 76. Minor planet (103) discovered by Watson, 1868.
8. Fire-ball, accompanied by the fall of a meteorite, at Languis, Lower Pyrenees, France, 1868.
9. Admiral Smyth, *d.* 1865, *æt.* 78 (author of a "*Cycle of Celestial Objects*," "*Speculum Hartwellianum*," &c. &c. Large comet,

Days

perceived at first in Italy by a monk, 1807. Melete discovered by Goldschmidt, 1857. Danaë discovered by the same, 1860.

10. Alexandra discovered by Goldschmidt, 1858. Pandora discovered by Searle, 1858.

11. L. Godin *d.* 1760.

12. Olympia discovered by Chacornac, 1860.

13. Victoria discovered by Hind, 1850 (discoverer of 10 minor planets). Niobe discovered by Luther, 1861. Minor planet (104) discovered by Watson, 1868. John Brinkley *d.* 1835, *æt.* 72 (Bishop of Cloyne).

14. J. D. Cassini began his duties at the Paris Observatory, 1671, *d.* 1712, *æt.* 87. Erato discovered by Förster, and Echo by Ferguson, 1860. Eurynome discovered by Watson, 1863.

15. Mercury, Venus, Mars, Jupiter, and Saturn in conjunction, between the Wheat-ear of Virgo, and Libra, 1186. Aglaia discovered by Luther, 1857.

16. Large stone fell at Kleinwenden, Thuringia, 1843. Minor planet (105) discovered by Watson, 1868 (discoverer of 9 minor planets). Hyperion first seen by Bond, 1848.

17. Mimas discovered by Sir W. Herschel, 1789.

18. Hyperion seen by Lassell, 1848.

19. Römer *d.* 1702, *æt.* 58. Massilia discovered by De Gasparis, 1852, and by Chacornac on the 20th. Doris and Pales discovered by Goldschmidt, 1857. Io discovered by Peters, 1865. Discovery of Hyperion verified by Bond and Lassell. J. P. Nichol (Glasgow) *d.* 1859, *æt.* 55.

20. Méchain *d.* 1805, *æt.* 31.

21. Ivory *d.* 1842, *æt.* 77. Statue of Sir I. Newton inaugurated at Grantham by Lord Brougham, 1858.

22. Mnemosyne discovered by Luther, 1859. Eurydice discovered by Peters, 1862.

23. Neptune found by Dr. Galle (Berlin) 1846, by means of its position indicated by M. Le Verrier in his letter of September 18th.

24. Total eclipse of the sun, observed in the north of Europe, 1699.

25. J. H. Lambert *d.* 1777, *æt.* 49.

26. Adrian Metius *d.* 1635, *æt.* 64.

27. Jupiter (apparently) without his satellites for 35m., observed by Dawes and W. Griesbach, 1843. First meeting of the British Association at York, 1831. Among its original promoters, Rev. W. Vernon Harcourt, and Prof. Phillips.

28.

29. Halley's comet passed almost centrally over a star of 10th magnitude, without any effect on the light of the star (Bessel), 1835.

30. John Dollond *d.* 1761, *æt.* 55. Solar spot observed, 143,808 miles in breadth, 1858. Terpsichore discovered by Tempel, 1864.

OCTOBER.

הֵן עַד־יָרֵחַ וְלֹא יַאֲהִיל וְכוֹכָבִים לֹא־זַכּוּ בְעֵינָיו : אַף כִּי־אֱנוֹשׁ רִמָּה וּבֶן־אָדָם תּוֹלֵעָה :

"Behold even the moon, and it shineth not; and the stars are not pure in his sight: how much less man, (that is) a worm! and the son of man, (which is) a worm!"—Job xxv. 5, 6.

Days

1. Earliest observation of Halley as Astronomer-Royal, 1721. Robert Simpson *d.* 1768, *æt.* 81. Miss Mitchell, U.S., received a gold medal from the King of Denmark for the discovery of a comet, 1847. Antiope discovered by Luther, 1866.
2. G. B. Airy, Astronomer-Royal, began his labours at Greenwich, 1835. Arago *d.* 1853, *æt.* 67.
3. Occultation (?) of Mars by Venus, 1590, witnessed by Mœstlin. Disappearance of a small nebula (variable) in Taurus, discovered by D'Arrest, 1861.
4. Virginia discovered by Ferguson, 1857 (by Luther on the 19th); discoverer of 3 minor planets.
5. Atalanta discovered by Goldschmidt, and Fides by Luther, 1855. Donati's comet passed over Arcturus, 1858.
6.
7.
8. Longomontanus *d.* 1647, *æt.* 85; first Director of the Observatory of Copenhagen, the earliest national observatory of Europe.
9. General Colby *d.* 1852, *æt.* 68.
10. David Gregory *d.* 1708, *æt.* 47. New star in Ophiuchus, first seen by John Brunowski, the pupil of Kepler, 1604. M. Weisse of Cracow, editor of Bessel's star-zones, *d.* 1863, *æt.* 65. Satellite of Neptune, discovered by Lassel, 1846. Great sun spot, 1865 (Lockyer). Minor planet (106) discovered by Watson, 1868.
11. Small nebula in Taurus discovered by Hind, 1852, variable. Tschirnhausen *d.* 1708, *æt.* 57.
12. Venus seen by Timocharis to eclipse a star in Virgo, B.C. 271 (Almagest). Greatest breadth of the tail of the great comet of 1811, 15,000,000 miles (Herschel). Cornelius Gemma *d.* 1577, *æt.* 42.
13. Saturn's ring first seen double by the brothers Ball, 1665. G. Montanari *d.* 1687, *æt.* 55.
14. Gassendi *d.* 1655, *æt.* 63. J. Dalby *d.* 1824, *æt.* 80.
15. Torricelli *b.* 1608, *d.* 1647, *æt.* 39. Tail of the great comet of 1811, according to Herschel, above 100,000,000 miles long.
16. Schmidt suspects a change in the lunar spot Linné, 1866.
17. Satellites of Jupiter observed by Harriot, 1610. Splendid new star in Serpentarius, seen by Kepler, 1604. Count J. D. Cassini *d.* 1845, *æt.* 97.
18. Flora discovered by Hind, 1847.
19.
20. Spectrum of a solar prominence seen by Mr. Lockyer (without an eclipse) 1868. The same thing effected by Mr. Janssen, August 19th, in India.

Days

21. Römer's observations and instruments destroyed by fire at Copenhagen, 1728. Freia discovered by D'Arrest, 1862.
22.
23. Sir James South *d.* 1867, *æt.* 82.
24. Tycho Brahé *d.* 1601, *æt.* 55. W. Schickard *d.* 1635, *æt.* 43.
25. The National Institute of France established, 1795. Niépce de Saint-Victor presents to the Academy of Sciences, Paris, his first Memoir on Photography on Glass, 1847.
26. Pomona discovered by Goldschmidt, 1854.
27. Lord Wrottesley *d.* 1867, *æt.* 79.
28. J. Wallis *d.* 1703, *æt.* 87. Polyhymnia discovered by Chacornac, 1854.
29. D'Alembert *d.* 1783, *æt.* 66.
30. Prof. (General) O. M. Mitchell *d.* 1862, *æ.* 52.; director of the Dudley Observatory, U.S.
31. Ebn Yunis observed a conjunction of Jupiter and Saturn at Cairo, A.D. 1007. W. Snell *d.* 1626, *æt.* 35. Lord Rosse *d.* 1867, *æt.* 64.

NOVEMBER.

הַלְלוּהוּ שֶׁמֶשׁ וְיָרֵחַ הַלְלוּהוּ כָּל־כּוֹכְבֵי אוֹר ׃ הַלְלוּהוּ שְׁמֵי הַשָּׁמָיִם וְהַמַּיִם
אֲשֶׁר מֵעַל הַשָּׁמָיִם ׃ יְהַלְלוּ אֶת־שֵׁם יְהוָה כִּי הוּא צִוָּה וְנִבְרָאוּ ׃ וַיַּעֲמִידֵם לָעַד
לְעוֹלָם חָק־נָתַן וְלֹא יַעֲבוֹר ׃

"Praise ye him, sun and moon: praise ye him, all ye stars of light. Praise ye him, ye heavens of heavens; and ye waters that (are) above the heavens. Let them praise the name of Jehovah: for it was he that commanded, and they were created; he hath also established them for ever and ever; he hath made a statute which shall not pass away."—Ps. cxlviii. 3—6.

1. Comet discovered, 1577. Observed by Tycho Brahé for the detection of parallax.
2. Transit of the shadow of Titan across Saturn, seen by Sir W. Herschel, 1789 (same phenomena seen in 1862 by Dawes and others). Egeria discovered by De Gasparis, 1850.
3. Transit of Mercury, 1651, to observe which Jeremiah Shakerly went to Surat in India.
4. Ægina discovered by Stephan, 1866.
5. J. Ramsden *d.* 1800, *æt.* 65.
6.
7. First recorded transit of Mercury, predicted by Kepler, and observed by Gassendi at Paris, 1631. Large stone of 260 lbs. fell at Ensisheim, Upper Rhine, 1492. Halley observes the transit of Mercury over the sun, at St. Helena, 1677.
8. Euterpe discovered by Hind, 1853. G. Peacock *d.* 1858 (Dean of Ely).
9. New star in Cassiopeia seen by Cornelius Gemma, 1572 (by Hainzel at Augsburg on 7th), seems to have been discovered on August 6th by Schuler, at Wittemberg.
10. First Memoir on the Theory of Uranus, by Le Verrier ("*Comptes Rendus*"), 1845.

Days

11. New star in Cassiopeia seen by Tycho Brahé, 1572. Dusky ring of Saturn discovered by Bond, Cambridge, U.S., 1850, and by Dawes on the 25th.
12. J. S. Bailly executed at Paris, 1793 (Q. 11th Nov.?). Prodigious fall of shooting stars observed at Cumana, by Humboldt and Bonpland, 1799.
13. Brilliant display of meteors, as expected by Olbers, on the night of the 13–14th, 1866. One considerably finer, Nov. 13th, 1833, seen in America.
14. Great comet first seen by G. Kirch, at Coburg in Saxony, 1680. Leibnitz *d.* 1714, *æt.* 68. Clairaut announced to the Academy of Sciences the result of his calculations on the return of Halley's comet, 1758. Thos. Mudge (Improver of Chronometers) *d.* 1794, *æt.* 79.
15. Most ancient recorded observation of Mercury, B.C. 265 (Almagest). De Vico *d.* 1848, *æt.* 43. Lutetia discovered by Goldschmidt, 1852. Frigga discovered by Peters, 1862. Detonating meteor, visible in full sunlight, passed over New Jersey, with a series of terrific explosions, 1859.
16. Calliope discovered by Hind, 1852. James Ferguson, *d.* 1776, *æt.* 66.
17. Camilla discovered by Pogson, 1868 (discoverer of 7 minor planets).
18. Comet seen passing across the sun, 1826 (Gambart and Flaugergues).
19.
20.
21. Large meteor seen in parts of the United States, *actual* diameter appeared to be nearly half a mile; height, 38 to 22 miles, 1819. Another of great brilliancy, in sunshine, Edinburgh, 1828; diameter, 1,320 yards; altitude, 60 miles.
22. Paolo Frisi *d.* 1784, *æt.* 67. Castor occulted by Jupiter, seen by Pound, 1716. Periodic comet discovered by Faye, Paris, 1843.
23. Thos. Henderson *d.* 1844, *æt.* 46; had charge of the observatory at the Cape of Good Hope, and was afterwards the first Astronomer Royal for Scotland. F. G. W. Struve *d.* 1864, *æt.* 72. Arethusa discovered by Luther, 1867. J. E. Bode *d.* 1826, *æt.* 79.
24. Transit of Venus observed by Horrocks and Crabtree, 1639.
25. Bouillaud (Bullialdus) *d.* 1694, *æt.* 89. Dusky ring of Saturn discovered by Dawes, 1850.
26. Encke's comet discovered by Pons at Marseilles, 1818 (discoverer of 28 comets, whose orbits have been computed). Wheatstone's electro-magnetic clock described in a communication to the Royal Society, 1840.
27. Meteoric stone of 59 lbs. fell at Mont Vasier, Provence, 1627, witnessed by Gassendi. Demoivre, *d.* 1754, *æt.* 87. Alcmene discovered by Luther, 1864.
28. Earliest official document of the Royal Society, 1660. Matthew Young *d.* 1800, *æt.* 50 (Bishop of Clonfert).
29.
30. Splendid comet, 1618; tail, according to Longomontanus, 104° long; said to have been visible in the daytime. The Copley medal awarded by the Council of the Royal Society to Mr. (Sir James) South, for his observations of double stars, 1826.

DECEMBER.

לְפָנִים הָאָרֶץ יָסַדְתָּ וּמַעֲשֵׂה יָדֶיךָ שָׁמָיִם׃ הֵמָּה יֹאבֵדוּ וְאַתָּה תַעֲמֹד וְכֻלָּם
כַּבֶּגֶד יִבְלוּ כַּלְּבוּשׁ תַּחֲלִיפֵם וְיַחֲלֹפוּ׃ וְאַתָּה הוּא וּשְׁנוֹתֶיךָ לֹא יִתָּמּוּ׃

"Of old hast thou founded the earth, and the heavens (are) the work of thy hands. As to them, they shall perish; but as to thee, thou shalt endure. Yea, all of them shall grow old like a garment, as a vestire shalt thou change them, and they shall be changed; but thou (art) the same, and thy years shall have no end."—Ps. cii. 25—27.

Days

1. J. G. Doppelmayer *d.* 1750, *æt.* 79. Fine comet first seen in Switzerland, 1823. J. P. Maraldi *d.* 1729, *æt.* 64.
2.
3. Cavalerius *d.* 1647, *æt.* 49.
4. Rheticus *d.* 1576, *æt.* 63. Sir W. Herschel began a series of observations of Saturn, 1793, resulting in the accurate determination of its period of rotation.
5.
6.
7.
8. Astræa discovered by Hencke, 1845.
9. Most brilliant comet of the 18th century, first discovered by Klinkenberg at Haarlem, 1743; visible to the naked eye at 1 P.M., March 1st, 1744, only 5 hours after P.P. George Boole *d.* 1864, *æt.* 45.
10. Edmund Gunter *d.* 1626, *æt.* 45.
11. Large fire-ball burst over Macao, Brazil, followed by the fall of several stones from 1 lb. to 80 lbs.; they fell through the roofs of several houses deep into the ground, killing and maiming a few oxen, 1836.
12. Date of the warrant of Anne, appointing visitors to inspect Greenwich Observatory, 1710.
13. Frederick II. of Germany *d.* 1250; *Almagest* first translated under his auspices. Flamsteed observes Uranus as a fixed star, 1690. Wargentin *d.* 1783, *æt.* 66. Meteoric stone of 56 lbs. fell at Wold Cottage, Yorkshire, 1795. F. Vieta *d.* 1603, *æt.* 63 (13th?).
14. Shower of meteoric stones, Weston, Connecticut, U.S. 1807.
15. Comet discovered by Miss Herschel, 1791. Thalia discovered by Hind 1852. Great nebula, 31 M Andromedæ, first examined with a telescope by Simon Marius, 1612.
16. Series of observations of Jupiter begun by Mr. Airy at Cambridge, 1834, resulting in the determination of its period of rotation to a high degree of accuracy. R. Long D.D. *d.* 1770, *æt.* 90.
17. Great comet of 1680 at its perihelion.
18. Montucla *d.* 1799, *æt.* 74. J. C. F. Sturm *d.* 1855, *æt.* 52.
19. Shower of meteoric stones, Benares, 1798. Venus and Saturn in the same field of the telescope, 1845.
20.

Days.

21. Kepler *b.* 1571 (he was a seven months' child, very weak and sickly), *d.* Nov. 1630, *æt.* 59; he published the Rudolfine Tables, 1627. Observation of γ Draconis by Bradley, leading to the discovery of the aberration of light, 1725.

22. First meeting of the Royal Academy of Sciences, Paris, 1666. W. Wollaston *d.* 1828, *æt.* 52.

23. Rhea discovered by Dominic Cassini, 1672. Robert Woodhouse *d.* 1827, *æt.* 54.

24. Date of Professor Henderson's paper on the Parallax of α Centauri, 1838 (Bessel announced the discovery of the parallax of 61 Cygni, December 13th, 1838).

25. George Palitzch, a farmer near Dresden, first sees Halley's comet at its first *predicted* apparition, with an 8-foot telescope, 1758.

26. C. L. Rümker *d.* 1862, *æt.* 75; for 10 years at Paramatta Observatory, New South Wales.

27. Sir W. Herschel saw a facula (bright streak) on the sun, 74,368 miles long, 1799.

28. Schumacher *d.* 1850, *æt.* 70; established the "*Astronomische Nachrichten*" in 1813. F. M. Grimaldi *d.* 1663 *æt.* 44.

29. Brook Taylor *d.* 1731, *æt.* 46. Hind's variable nebula in Taurus seen again after its disappearance, at Pulkova, in the 15-inch refractor, 1861. Mary Margaret Kirch *d.* 1720, *æt.* 50.

30\.

31. Flamsteed *d.* 1719, *æt.* 73.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

THE ASTRONOMICAL REGISTER.

THE

ASTRONOMICAL REGISTER:

A MEDIUM OF COMMUNICATION
FOR AMATEUR OBSERVERS, AND ALL OTHERS INTERESTED IN THE
SCIENCE OF ASTRONOMY.

VOL. VII.
NOS. 73 TO 84: JANUARY TO DECEMBER, 1869.

LONDON:
J. D. POTTER, 31, POULTRY, & 11, KING STREET, TOWER HILL,
1870.

LONDON
SPOTTISWOODE AND CO., NEW STREET SQUARE
1869

THE ASTRONOMICAL REGISTER.

INDEX TO VOLUME VII.

N. B.—Pages 245, 246, 247, and 248 have been repeated in error, and should be 249, 250, 251, and 252. They are denoted in the Index by an asterisk.

Abbott, on Eta Argûs, 14
—— — Transit of Mercury, 80
Adams Prize Essay, 144
Address, 1
Airy, on the Transits of Venus, 3, 11, 80
—— — Counteraction of atmospheric dispersion, 230
Aldebaran, Companion to, 19, 52, 73, 96
American Photographs of Solar Eclipse, 237
Ashe, on Determination of longitudes by telegraph, 99
Astronomische Gesellschaft, 27
ASTRONOMICAL OCCURRENCES:—
Jan., 30 July, 166
Feb., 54 Aug., 182
March, 74 Sept., 188
April, 94 Oct., 206
May, 118 Nov. 224
June, 142 Dec., 246*
Astronomical Observations, delicate 246
—— Photography, 51, 64
—— Societies, 248
Astronomy, National support of, 76
Atmospheric dispersion, counteraction of, 230
Aurora Borealis, 97, 135, 186
—— Spectrum of, 185

Backhouse, on the Moon's rotation, 115
—— — Spectrum of Aurora, 185
Banks, on Jupiter's Satellites, 164
Barneby, on the Transit of Mercury, 80
Baxendell, on Vulcan, 113
—— — Corona at Eclipses, 130
Bedford, on Winnecke's Comet, 140
Beechey, on Test Objects, 19
Bidder, on Sun Spots, 123
Bird, on the Non-rotation Theory, 140
—— — Triple Star in Draco, 218
Birmingham, on January meteors, 50
—— — Sun Spots, 169
Birt, on Linné, 144
—— — Lunar Spots, 178, 221
—— — Floor of Plato, 237
—— — Delicate Astronomical Observations, 246
—— New Lunar Map, 256
Blacklock, on Tarnishing of Reflectors, 52
—— — Planetary Transits and Aurora, 186
Brayley, on luminous prominences, 43
—— — Sun Spots, 155
Bright Objects passing the Sun, 138, 185
Brothers, on Astronomical Photography, 64
Browne, on the Solar Eclipse of 1598, 111
Browning, on the Transit of Mercury, 13
—— — Mounting of finders, 81
—— — Sun Spots, 82, 123
—— — a Spectroscope, 156
—— — Jupiter's Belts, 236
Buffham, on Jupiter's Satellites, 49, 71, 185
—— — Zeta Cancri, 70, 222
—— — Reflectors and Refractors, 158
Burr, on the Solar Eclipse of 1868, 186

Carrington, Observatory at Chert, 230
Cassiopeia, 257
Cayley, on Attraction of Ellipsoids, 81
——— — Determination of a Planets orbit, 105
Celestial Objects, 135
Chambers, on Winnecke's Comet, 72, 140, 219
——— — Statistics of observatories, 116
——— — Vulcan, 114
Comets, Theory of, 45, 172, 180
——— Nucleus of, 197
Comet, Winnecke's, 72, 96, 117, 122, 140, 217, 219
——— II., 1867, 73
Corona at Eclipses, 130

Dawson, Theory of Comets, 45
——— on Large Object-glasses, 246
De la Rue, on the Transit of Venus, 11
——— — Solar Eclipse of August, 1868, 39, 83
——— — Photographic Observations of transits, 128
Denning, on Jupiter, 16, 71
——— — Mercury, 64
——— — Magnifying Powers, 71
——— — Vulcan, 89, 113
——— — Occultation of Regulus, 139
——— — Conjunction of Mars and Moon, 139
Donati, on Solar Phenomena, 240
Double Star Colours, 219
Draco, Triple Star in, 218
Driving Clock, improved, 105
Dunkin, on Lunar Transits, 105

ECLIPSE OF THE MOON, 32, 76, 90, 114
——— of the Sun, August, 1868, 35, 45, 83, 107, 131, 186
——— ——— August, 1869, 81
——— Solar, 87, 111
Elger, on Vulcan, 164
Ellipsoids, Attraction of, 81
Elvins, on Saturn's Ring, 69
——— — Theory of Comets, 172
——— — Nucleus of Comets, 197
——— — the Moon, 260
Erck, on Construction of Observatories, 176
Eta Argûs, 14, 122

FINDERS, MOUNTING OF, 81
Florence Observatory, Inauguration of, 213
Fomalhaut, 28
Frankland, Spectroscopic Observations, 194, 254

Gibbs, on the Motion of the Moon, 67
Gilby, on Uranus, 117
Gill, on Prisms for Reflectors, 21
Gold Medal of the Astronomical Society, presented to Mr. Stone, 62
Gorton, on an observing seat, 79
Gould, on Jupiter's Satellites, 221
Greenwich Observatory, 190
Gribble, on an Eclipse of the Moon, 114
——— — Jupiter's Satellites, 221
Grover, on Reflectors and Refractors, 23, 65
——— — High powers with Reflectors, 191
——— — Wonders and Beauties of the Heavens, 257
Guyon, on an observing seat, 78

HACKNEY SCIENTIFIC ASSOCIATION, 227
Harvest Moon, 24
Herschel, on the November meteors, 234
——— J., on Spectroscopic Observations of the Sun, 255
High Powers, Use of with Reflectors, 191
Hind, on Solar Eclipses, 81, 87
——— — Winnecke's Comet, 96
——— — Transit of Venus, 146
——— — Medal for Discovery of Minor Planets, 245*
Holden, on artificial Transits, 162
——— — Minor Planets, 223
Hollis, Imitation of a Transit, 125
Huggins, Spectroscopic Observations, 194
Hunt, on Jupiter's Satellites, 17, 49

Jackson, on the Harvest Moon, 25
Janssen, on Solar Eclipse of 1868, 107, 131
Johnson, on Auroral Display, 136
——— — Astronomical Societies, 248
Joynson, on Jupiter's Satellites, and Occultations of Stars, 17, 81
——— — Opposition of Mars, 121
——— — Occultations, 122, 145
——— and *Williams*, on the Mare Serenitatis, 33
Jupiter, 15, 16, 19, 217
Jupiter's Belts, 236
——— Satellites, 17, 48, 53, 71, 111, 164, 185, 221, 223, 247, 248

Key, on Zeta Cancri, 171
Kincaid, on a Driving Clock, 105

Lawton, on Auroral Display, 138
Linné, the Lunar Crater, 144
Lockyer, on the Red Flames, 42
——— — Spectroscopic Observations, 194, 209, 243, 253
Longitude, Determination of, by Electric Telegraph, 99
Loomis, on Eta Argûs, 122
Luminous Prominences, 43
Lunar Chemistry, 50
——— Monograms, 102
——— Map and Catalogue, 212
——— Observations, 217
——— Surface, 256
——— Map, 256

Maclear, on the Transit of Mercury, 80
——— — Meteors of November, 1868, 80
Madler, on the Moon, 25
Magnifying Powers, 71
Mare Serenitatis, the, 33
Mars, 56
——— Rotation of, 84
——— Opposition of, 121
——— Conjunction with the Moon, 139
Mercury, 64
——— Transit of, 13, 20, 50, 80, 90
Meteor, brilliant, 52, 247
Meteors, November, 28, 80, 234, 248*
——— January, 1869, 50
——— August, 216
——— 248
Moon, Motion of, 67
——— Rotation of, 115
——— A habitable globe, 115
——— White Spots on, 221
——— Eclipse of, 32, 76, 90, 114
——— Harvest, 24
——— Nature and Physical Constitution examined, 260

Nasmyth, Models of the Lunar Surface, 256
NEBULÆ, DISTRIBUTION OF, 150
Neptune, 56, 248
Non-rotation theory, The, 140
November Meteors, The, 28, 80, 234, 248*
Numbers engraved on scientific instruments, 146

Object Glasses, Large, 179, 246
Observing Seats, 77
——— Society, New, 165
——— ——— Report, 216
Observatory, Greenwich, 100
——— Florence, [illegible]
——— Mr. Carring[illegible]
Observatories, Construction of, 116, 163, 176
——— Statistics of 116
Occultations of Stars, 17, 81, 96, 122, 198, 218

Payne, on a brilliant meteor, 247
Pear-shaped Elongation, 111, 180
Penrose, on Occultations, 198
Perigal, on Rotation and Revolution, 68
Personality in Transit Collimation, 80
——— in Lunar Transits, 105
Photographic Observations of Transits, 128, 235
Photography, Astronomical, 51, 64
Planet, Intra-Mercurial, 227
——— Minor, 32, 223, 245,* 248
Planetary Transit, 186
Planets' Orbits, Determination of, 105
Planets, The, at Transit over the Meridian, for
Jan., 32 July, 168
Feb., 56 Aug., 184
March, 76 Sept., 187
April, 96 Oct., 205
May, 120 Nov., 223
June, 144 Dec., 245*
Plato, Floor of, 237, 178
Plummer, on Aurora Borealis, 97
——— — Occultations, 122
Pratt, on Transit of Mercury, 20
Prisms for Reflectors, 21
Proctor, on Rotation of Mars, 84
——— — Transit of Venus, 86, 111, 126
——— — Distribution of Nebulæ, 150
——— — The Zodiacal Light, 218
——— — Photography applied to Transits, 235
Prowde, on Lunar Eclipses and Transit of Mercury, 90
——— — Auroral Display, 135

Rayet, on Solar Eclipse, 1868, 133
Red Flames seen without an eclipse, 42
Reflectors and Refractors, 21, 65, 158
——— Tarnishing of, 52
Regulus, Occultation of, 120, 139

REVIEWS:
Birt, Mare Serenitatis, 120
Browning's Stereograms of Mars, 240
Dunkin's Midnight Sky, 239
Keith Johnston's Atlas of Astronomy, 120
Merrifield and Evers, on Navigation and Nautical Astronomy, 27
Penrose's Predictions of Occultations, 181
Proctor's Star Atlas, 226
Warner's How to keep the Clock right, 239
Rotation, 68, 91, 177, 204
ROYAL ASTRONOMICAL SOCIETY'S MEETINGS:—
Dec. 11, 1868, 3 — April 9, 1869, 97
Jan. 8, 1869, 35 — May 14, „ 121
Feb. 12, „ 57 — June 11, „ 145
Mar. 12, „ 79 — Nov. 12, „ 229

SATURN'S RING, 69
Scientific Nursery Rhymes, 245*
Secchi, on the constitution of the Sun, 84
Shooting Stars, 208
Solar Phenomena, 139, 240
Spectroscope, 156
Stone, on Personality in Transit Collimation, 80
——— — Transit of Venus, 103
Stonehenge, on the Temple at, 202
Strange, on Numbers engraved on scientific instruments, 146
——— — Illuminating verniers, 149
Sun, Distance of, 15, 65, 88
——— Spots, 82, 123, 155, 169, 223
——— Constitution of, 44, 84
——— Spectroscopic Observations of, 193, 209, 243, 253
——— Eclipse of, 35, 45, 81, 83, 87, 107, 111, 131, 186

Tebbutt, on Eta Argûs, 122
Telescope, Cassegrainian, 248
Tennant, on Solar Eclipse, 1868, 35
——— — Photographic Observations of Transits, 128
Test objects, 19
Toronto Astronomical Club, 51
Transit, Imitation of, 125, 162
——— of Mercury, 13, 20, 50, 80, 90
——— Venus, 3, 11, 52, 80, 86, 103, 110, 126, 146, 208
Tyndall's Theory of Comets, 180

URANUS, 56, 117

VARIABLE STAR IN GEMINI, 117
Velocities of Celestial and Terrestrial Bodies, 199
Venus, Transit of, 3, 11, 52, 80, 86, 103, 110, 126, 146, 208
Verniers, Illumination of, 149
Vision, Powers of, 51
Vulcan, 89, 113, 164, 227

Walker, on the Harvest Moon, 24
——— — Jupiter's Satellites, 48, 53
——— — Occultations, 96
——— — Occultation of Regulus, 139
——— — Velocities of Celestial and Terrestrial Bodies, 199
——— — Neptune, 248
Walton, on Lunar Chemistry, 50
Ward, the Hon. Mrs., 226
Watson, the Moon a habitable Globe, 115
Webb, on Reflectors and Refractors, 21
——— — Photographs of Solar Eclipse, 237
——— — Jupiter's Satellites. 247
Whitehouse, on Jupiter, 15
——— — Large Object-glasses, 179
Whitley, on the Transit of Mercury, 50
——— — Double Star Colours, 219
Williams, on an Observing Seat, 79
Wilson, on an Observing Seat, 78
Wonders and Beauties of the Heavens, 257
Wortham, on Winnecke's Comet, 122

ZETA CANCRI, 70, 171, 222
Zodiacal Light, 218

Names of New Subscribers, Instruments for Sale, &c.
Notices to Correspondents, &c., &c.

APPENDIX.

List of Anniversaries of Remarkable Astronomical Discoveries, &c.
BY G. J. WALKER, ESQ.
On The Signs of The Zodiac. BY THE REV. J. H. BROOME.

ENGRAVINGS.

The Mare Serenitatis, *Frontispiece.*
Revolution and Rotation Page 68
Observing Seats 77
Sun Spots (2 plates) ... Page 169
Theory of Comets, 173, 174, 175, 193
Original Plan of Stonehenge...... 193

The Astronomical Register.

No. 73. JANUARY. 1869.

ADDRESS.

Of all the sciences there is perhaps not one concerning which greater general ignorance has prevailed among all classes of the community than the science of Astronomy. "The stars" have, it is true, exercised from time immemorial a kind of mysterious influence over mankind, who have been wont to see in the heavenly luminaries the malevolent cause of many dire disasters and misfortunes of which they were wholly innocent; but as to any rational ideas of the principles of astronomical science, the general body of the people may be said to have been wholly without them. Advantage of this prevailing ignorance (as was to be expected) has been taken by crafty and designing charlatans; hence the success and vast sale of such things as astrological and prophetic almanacs, pamphlets, weather guides, &c., which have been and even still are so popular, many of them being by no means confined to mere predictions, but often fearlessly attacking theories which not only are received by those whose labours and acquirements have enabled them to form a just estimate of their truth, but which ought to have the strongest claims to the respect of those who have sufficient education and intelligence to be capable of examining for themselves the evidences upon which such theories rest, and which therefore are entitled to be considered as established so far as scientific investigation and deduction has been brought to bear upon them. The enormous sale and circulation of these ridiculous publications is by no means limited, as might be supposed, to the lower or less educated classes; they are eagerly purchased and consulted by numbers of persons whose knowledge is expected to extend to the classics as well as the ordinary modern accomplishments. There are indeed certain well-defined branches of study with which those who as a matter of course receive what is termed a liberal education are assumed to be familiar, or if they should prove to be unacquainted therewith it would certainly excite surprise; but until a comparatively recent period at all events, even if it be so now, it has never been thought by any means necessary that the merest rudiments of astronomical science should be taught. Perhaps it is not too much to say that when an instance occurred of an individual becoming addicted to star-gazing he was pretty sure to be regarded by his friends and acquaintances with feelings of tender solicitude not unmixed with a certain commiseration, and if not set down as a hopeless lunatic *in posse*, was at all events a dreamy enthusiast *in esse*, and those having the charge of him were seriously recommended to look well after him, and, if possible, prevent his mind becoming too much absorbed in the contemplation of objects *such a very long way off*, and from which no possible good could come!

We are of opinion, however, that there will, ere long, be an end of these ignorant and foolish prejudices, and that the possessor of a telescope will not be much longer in danger of being presented to the Zoological Society, to be added to their collection as a rare and curious specimen of humanity. There can be no doubt that a great and growing interest in astronomical matters and phenomena has of late sprung up among the general public, which would appear to be, and we trust is, steadily increasing. It is particularly noticeable among the higher class of artisans and mechanics, many of whom indeed manifest an amount of information and intelligence, and even considerable reading upon scientific subjects, which it is both a surprise and pleasure to observe. We have, we think, ample justification for this statement in the fact that numerous and able articles are inserted (rather as a rule than an exception) in the magazines, the daily and weekly papers, and also into the other publications which have become universally popular among the so-called working-men, to say nothing of the correspondence to be met with therein, replete with enquiries and requests for advice and instruction upon astronomical matters from those able and willing to afford it. Again, we consider our opinion is further confirmed by the greatly extended manufacture of astronomical instruments, and the greatly reduced prices at which the same can be obtained—not instruments of the highest excellence, perhaps, but still of respectable quality and efficiency, and which, at least, go to prove that there is a very much increased demand for such things, purchasers being readily found for them when brought within the reach of limited means. There is, moreover, no lack of astronomical works issuing from the press to supply the wants of those who are disposed to dip below the surface of the science, while the articles, notes and correspondence so frequent in publications of a general character, more especially those written in a popular and attractive style, serve to awaken and sustain that interest in others who may be unable to devote much of their time to the study of the more abstruse branches of astronomy, but who nevertheless fail not to recognise and enjoy many of its grand though simpler beauties.

We sincerely trust that our *Register* continues to meet with the general approbation of its subscribers. Notwithstanding its many shortcomings, of which we are fully sensible, we believe we are, at least, entitled to claim for it that it satisfactorily fulfils its original purpose, namely, the affording a convenient and ready means of communication between those who, either professionally or as amateurs, are engaged in the pursuit of our noble science. Nothing tends so much to disperse and expose crude and ill-founded notions and theories, and at the same time to confirm and establish those that are sound and truthful, as discussion; and this it is our especial desire and object to facilitate and encourage, being persuaded that it can never prove otherwise than of service and advantage both to the science and its devotees.

In the confident reliance upon receiving the co-operation and support of our kind friends, and resolving to do all that in us lies to deserve their favourable consideration, we commence this day our Seventh Volume.

January 1, 1869.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868–9.

Second Meeting, December 11, 1868.

Admiral Manners, *President*, in the Chair.

Secretaries—Mr. Stone and Mr. Huggins.

The Minutes of the last meeting were read and confirmed.

Twenty-seven presents were announced, and the thanks of the Society voted to the respective donors.

The Rev. Charles Gribble,
W. Vines, Esq., and
Dr. George Neumayer,

were ballotted for, and duly elected Fellows of the Society.

The following papers were read:—

On the Preparations for Observing the Transits of Venus in 1874 *and* 1882: by the Astronomer-Royal.

The author, in giving an oral abstract of his paper, said, that on two former occasions he had called the attention of the Society to this subject, which, as the transits were now rapidly approaching, demanded that distinct details should be furnished, and active preparations for the observations at once commenced. The publication of M. Leverrier's new Tables of Venus, and the results deduced from them by Mr. Hind, also render the present time peculiarly appropriate for reverting to the matter. In 1769 the method adopted for obtaining the difference of parallax of the sun and Venus was, by observing the difference of the times occupied by the passage of the planet at stations, the one of which had the sun rising, and the other setting. This method cannot be adopted in 1874, and there will be great difficulty in obtaining a southern station in 1882. Now, without giving up the hope of obtaining such observations where the internal contact at both limbs can be seen, it is manifestly unsafe to trust to them alone, and recourse should also be had to the plan of observing the ingress and egress alone, as separate phenomena, at places opposite to one another, of which the longitudes are accurately known. The longitudes must be absolutely accurate to one second of time, and not mere approximations. The elements and all necessary data, according to Mr. Hind's computations, were given in Mr. Airy's paper, and from these, with the aid of a terrestrial globe, the proper stations could be easily selected. They must be chosen so that Venus is displaced by parallax on the sun's disc, in opposite directions. The Astronomer-Royal then referred to two maps, one of which contained a part of India and the Southern Ocean, having curved lines upon it, showing the proportional amount of parallax at each place, and horizontal lines giving the sun's altitude at the time of the transit. From this it appeared that the Island of Bourbon would be a good station in the first point of view, but the sun's elevation being only 4°, would render it unsafe to rely on. Kerguelen's Land, which had 0·92 for the factor of parallax, with the sun 24° high, was therefore much better. Madras gave only half the parallactic effect. The larger map was of the southern Polar district, and had been prepared by an officer who accompanied Sir James Ross in his Antarctic voyage. The lines upon it had the same significance as in the other. By the plan suggested, the ingress of the planet is a complete phenomenon in itself, and being observed at opposite sides of the earth, requires that at one station it should be accelerated by parallax and retarded at the other. The egress is also another complete phenomenon, requiring two stations for observations, similarly accelerated and retarded by parallax.

Mr. Airy exhibited two small maps, in illustration of his paper, to be bound face to face, showing the choice of stations for the ingress of the transit of 1874. Two others would be required for the egress; two for the ingress of the transit of

1882, and two for its egress, making eight in all; the whole of which he had prepared and described in detail. 1874. *Map* 1. *Ingress accelerated by Parallax.* Owyhee and the neighbouring islands afford excellent stations. The value of the parallax will be 0·92 of the whole, and the sun will be two hours above the horizon. The absolute longitude of the station chosen must be determined. The Marquesas Islands have a parallax factor of 0·7, and the sun sufficiently high. The French Government, always ready in the cause of science, may be relied on to do anything that is necessary here. The Island of Waihou would also answer for a station. The Aleutian Islands can scarcely be recommended, although the parallax is 0·8, and the sun fairly high; but the Russian Government may perhaps observe at the mouth of the River Amoor, where the parallax is 0·57, and the sun 15° high. For the British observations, Owhyee or Waihou seemed as good stations as could be chosen. *Map* 2. *Ingress retarded.* Kerguelen's Land, or the Island of Desolation, with a parallax factor of 0·91, and sun's elevation of 25°, appears the best station, but the naval authorities may be unwilling to send an expedition there. Creuzot's Island (sun 10° high), Rodriguez, Mauritius, and Bourbon come next in order. Mauritius will be good for both transits. Rodriguez will be preferable in 1874, as the sun will be at a good height; and Bourbon in 1882, so that if two longitudes can be obtained these should be the places, but if one only is to be got Mauritius should be chosen. Madras and Bombay have small parallax factors, 0·44 and 0·47, but the effect depends on the factors of both stations, so that they may be useful if well combined. It should be remembered that the longitudes observed for the transits will be zeros for future determinations of other places, and will thus be doubly beneficial to geography and astronomy. *Map* 3. *Egress accelerated.* Excluding for the present the Southern Polar Continent, the Auckland Islands, Auckland and Wellington, in New Zealand, Melbourne and Sydney appear suitable stations. Melbourne and Sydney having observatories, may be considered safe, but it is very desirable one of the New Zealand positions should have its longitude determined. *Map* 4. *Egress retarded.* These stations are all on Russian or Turkish territory. The parallax will be 0·84, but the sun's elevation must also be considered. Any place east or west of the Lower Caspian will do. Ourlsk, on the river of the same name, a tributary of the Volga, should be one, as, being the extremity of the great European arc of longitude measured by Otto Struve, its longitude has been determined to the fraction of a second. Astracan, Erzeroum, Smyrna, Alexandria (sun high), Tobolsk, Kazan (with the sun rather low), and Moscow, with it on the horizon, may all be named. Most of these places we may safely leave to Russia, but Alexandria may be considered as almost in British hands, and nothing should be spared in getting its longitude accurately. Probably there will soon be direct telegraphic communication to this place, which will be the best method, and, taking into account the time of year, it will certainly be a preferable station to Tobolsk for the observers.

Transit of 1882. The observations of this fall into two divisions, one being the method of observation of each phenomenon at stations having the longitudes known as in 1874; and the other, the method of getting the difference in the time of the whole transit. Referring to the first plan, the following maps are supplied:—1882. *Map* 5. *Ingress accelerated.* Omitting the Southern Continent, the desirable stations are Kerguelen's Land, parallax 0·98, sun 12° high; Creuzot's Island 0·9, sun 23°; Bourbon and Mauritius 0·88 (sun highest at Bourbon); the Cape of Good Hope 0·62. *Map* 6. *Ingress retarded.* The stations are every city on the sea-border of the United States, and every important city of Canada. The parallax will be 0·95, and the lowest elevation of the sun 12°; while the network of American telegraphs affords the readiest means of determining the longitudes. Jamaica, Bermuda, and the towns of Central America, are also available, but the longitudes are not so easily obtained. *Map* 7. *Egress accelerated.* All places from Halifax in Nova Scotia to New Orleans will be suitable. The factor of parallax is 0·85, and the sun will range from 4° high at Halifax to 35° at New Orleans. The coast of South America, from the Isthmus to Rio Janeiro, will also do. *Map* 8. *Egress retarded by parallax.* Sydney and Melbourne will answer well for these observations, having a parallax value of 0·96, and the sun 12° to 14° high. Should a New Zealand station have been used in 1874, observations there will be a valuable addition. The observations hitherto described involve a knowledge of the absolute longitudes of the stations, and the absolute time. The other method adopted in 1769 required the observation of both ingress and egress at a system of stations—one set being chosen so that the transit began in the morning and ended in the afternoon; the other beginning before midnight and ending after. This took the observers at one set of stations within the Arctic circle, but on the present occasion it must be the Antarctic; and although it is possible to be comfortable in the former position, the latter is very unlikely to be so. Maps 6 and 7 show that the North American stations leave nothing to be desired: at them the duration of the transit will be lessened by parallax. Maps 5 and 8 prove, that to obtain stations where the duration is increased by parallax we must go near the Southern Pole. The large map of these regions suggests two positions: the one is in about 7 hours of longitude; the other in a deep inlet of South Victoria, near Mounts Erebus and Terror. The coast forms nearly a parallel of latitude, having a parallax factor from 0·95 to 0·68. The sun will be about 3 hours from the meridian, but with an altitude of 4° only. Any alteration for the better as to one of these elements would lessen the value of the other. If a station as far as 72° of latitude could be reached up the inlet, it would be better than the one at 7 hours longitude: the sun would there be 10° high. This relates to the ingress; and if the expedition could be pushed on to the mountains Erebus and Terror, it would be still higher. For the egress, the parallax factors for the two stations are 0·78 and 0·58, with the sun 24° high. As to the choice of either of these stations, and the ability to reach them, we must trust entirely to the reports of Polar voyagers.

There may be a cause of uncertainty in Le Verrier's tables of Venus from Bradley's observations at a critical time not showing whether he observed the limb or centre of the planet. In reducing the Greenwich observations, Mr. Airy assumed that it was the limb, but Le Verrier treats the times recorded as if the centre were noted at the inferior conjunction. However, at present the tables are very accurate, and Le Verrier may be right. The longitudes which should be determined by the British observers will include Alexandria, a New Zealand station, Owyhee, Waihou, or some other in the Pacific, Kerguelen's Land or Creuzot's Island, the Mauritius, or Rodriguez and Bourbon. As to the methods of determining longitude; for Alexandria we may transmit Greenwich time by chronometers or telegraph signals. The latter mode is so great a saving of time and labour, that waiting a little for it should be preferred. The local time can be obtained by a transit or altazimuth. When trouble in calculation is not an object, the latter instrument is preferable, and in the last determination of the longitude of Valentia Mr. Dunkin used an altazimuth with the best results. The largest instrument that is portable should be preferred, and four reading microscopes to the circles are necessary. Such an instrument now forms part of the equipment at Greenwich. Clocks and chronometers are matters of course. The observers should be trained to use either instrument in case one breaks down, as the Royal Engineer Officers were who came to the observatory to be instructed before going out to trace the Maine boundary in North America through a most difficult country. For the New Zealand Station chronometers could be carried from Sydney or Melbourne. For Waihou or the Sandwich Islands steamers with chronometers from St. Francisco or the Cape of Good Hope would be an enormous expense (coals are £8 per ton at the latter), and economy in recommending things to Government must not be lost sight of. Mr. Airy was therefore disposed to rely on the moon. 100 transits of the moon half at each limb would give a result with a probable error three times that of the transit of a star, or equal to about a second of time. The same plan would do for the Mauritius or Rodriguez and Bourbon. It might be a question whether this work should be done before or after the transit of Venus. The British observers of 1874 would require five sets of instruments, and in 1882 three sets.

For observing in South Victoria it will be necessary to consult the accounts given by Sir James Ross and Captain Wilkes of the U.S. Navy, as to the probability of getting to the station in December. The author did not recommend a previous reconnaisance, but rather that the expedition should start in good time and go direct to the selected spot. A few days' observations for clock rates being obtained, the time would be all that could be required. The instruments should be seen about at once. They cannot be made in a hurry, and any defect or delay may cripple the expedition. As to details of the instruments and equipments, Mr. Airy trusted that Mr. Stone would attach his remarks and suggestions arising from the transit of Mercury to this paper. The telescopes should have apertures of 4 or 5 inches, and similar powers should be used. The modes of obscuring the light and counteracting atmospheric dispersion will require attention. An achromatized prismatic shade is the best for the former purpose, and as the planet must enter or emerge near the top or bottom of the sun, this near the horizon may require a prism cutting off the ends of the spectrum. The expedition of 1769 to the Pacific to observe the transit of Venus has always been considered one of the highest scientific glories of the past century, but the Astronomer-Royal hoped that it would be eclipsed by the efforts made with the same object in the present; and he concluded by reading an eloquent passage written by his predecessor Halley, in 1715, urging the necessity for such observations, and pointing out their important results. (Great applause.)

The President said the reception of the Astronomer-Royal's address relieved him from offering the formal thanks of the meeting to the author, but he could not refrain from expressing his personal sense of the devotion displayed by Mr. Airy to this subject, it being the third or fourth time on which he had brought the preparations required before the Society. On the present occasion it had been treated in such a lucid and comprehensive manner, and with such an exhaustive power with regard to details of data and equipment, as to deserve the warmest acknowledgments from all lovers of astronomy. He (the

President) saw that there were several naval officers present, particularly the hydrographer to the Admiralty, and he wished they would favour the meeting with their opinion as to the feasibility of the desired expedition to the South Polar Continents.

Capt. Richards said that the subject was the most important, in an astronomical point of view, of the present century, and he felt sure, that so far as the Admiralty was concerned, the Astronomer-Royal might be certain that everything he required would be attended to when the time came for active operations. With respect to the determination of longitudes, which had been so ably described, and by the use of which the first transit could only be made available, they presented no difficulty, but should be set about in good time. As to the second transit, for which similar observations could also be used, but as to which the Astronomer-Royal also desired an Antarctic station for observing the difference of time in the duration of the transit, there was of course a great deal to be done. He (Capt. Richards) did not know much of the locality, but he felt the ice would be a great obstacle, and he thought December was a month too early to be able to get to the perilous positions indicated. Probably it would be necessary to go out a year before and wait for the transit. It was also doubtful whether any suitable position could be obtained in 7 h. longitude, but at the inlet of South Victoria there was land which Sir James Ross reached, and observers could no doubt be landed. There may be some difficulties, but the Navy would overcome them, and there were hundreds of officers ready to go on such a voyage. Mr. Airy was the best judge whether this southern expedition should be pressed upon the Government, as the other observations offered no points of difficulty. This country had never ignored the claims of science, and no time should be lost in preparing the men and instruments for the observations.

The President: You are a great authority in matters of longitude, and I would ask whether we possess now the materials for giving those of the required places with the necessary accuracy, or whether we must send to make the determinations mentioned by Mr. Airy?

Capt. Richards: The longitude of Alexandria could probably be got in about a month.

The President: Is not the longitude of Rio Janeiro rather a vexed question?

Capt. Richards: It is not absolutely determined. Admiral Beechey obtained it, but afterwards we departed from his longitude, but have lately gone back to it. Mr. Airy thinks it would take a year to get these longitudes.

The Astronomer-Royal: That is, with observations of the moon.

Capt. Richards: The French are now occupied in obtaining the longitude of Rio, as also of some African stations.

Admiral Ommaney: The great thing which appears to me as necessary, is to urge the Government to make the required preparations at once. Mr. Airy thinks no reconnoitering necessary, but I side with Captain Richards in believing a preliminary survey is necessary. The Government cannot too soon send an expedition to see what South Victoria is made of, and considering that much improvement has taken place since Ross's time in ships, officers, and other appliances, I look for the happiest results.

Capt. Richards: I fear that it will be difficult to find a wintering place for the expedition, but as Ross got down to latitudes 72° and 75° in sailing ships, it would be possible for steamers, starting from Tasmania, to run down and land a party. I think the Government would prefer this plan. If not, as vessels cannot get down till January, the observers must be landed then, and wait till the following December.

Capt. Toynbee, from his knowledge of the eastern seas, recommended that several stations should be occupied, as it might happen that the sun might not be seen at one only.

Capt. Davies said he accompanied Sir James Ross in his southern voyage, and landed in latitude 72°, on Possession Island. He did not think any preliminary survey necessary, but the expedition must be there nearly a year before, as the instruments would take at least a month to be placed and adjusted, and it was idle to expect to get down to that latitude in November. They must therefore start so as to be there in the early part of the year 1882. Looking to the average of observations, he thought there was a better chance of seeing the sun, although only 4° high at South Victoria, than at Kerguelen's Land or Creuzot's Island. As to the position in 7 hours longitude, a steamer could get there, but there was no harbour, while at Possession Island the observers would have a good place, and, if well hutted, would not be uncomfortable, and there were plenty of penguins to eat.

Mr. De la Rue said that after the valuable information given by the nautical gentlemen present, he had but one suggestion to offer, which had struck him while the Astronomer-Royal was recommending that the observations should be made with the same kind of instruments, which was, that if the observers could be made alike also it would be very desirable. However, eyes were not similar, and he therefore suggested that artificial means of comparison should be used by the observers, either before or after the transit, so that uniformity in describing phenomena might be obtained. He hoped the naval gentlemen would write down and send in their remarks to accompany the paper, and he must bear testimony to the zeal with which the Astronomer-Royal pursued this important subject.

Col. Strange desired to confirm, from his own personal experience, the necessity for immediate action in the matter of preparing instruments, urged by Mr. Airy. In his case, as was well known, he required certain instruments to be constructed for the Indian survey. They were begun six years ago, but were not ready yet, or likely to be for six months at least. It was, therefore, not at all premature to consider the subject at once. To design such instruments always takes time. The greatest strength and power must be combined with the least possible weight. Every new instrument is a matter of experiment to the maker, which causes delay, and they must be most tediously examined, or failure at a critical moment might ensue.

On the Observation of the Transit of Venus by Photography: by Mr. De la Rue.

The Astronomer-Royal having intimated to Mr. De la Rue that he was about to read his paper on the coming Transits of Venus and requested him to add any suggestions as to the use of photography on those occasions, the author prepared the following remarks:—It was not intended that photography should supersede eye observations, but that the two methods should be combined. At the eclipse of 1860, photographs of the totality and of the phases before and after were obtained, which, being afterwards measured with a micrometer, contrived for the purpose (described in the *Phil. Trans.* 1862, where the results are also discussed), gave measures which, being compared with those calculated from the best elements by two independent computers, agreed remarkably well. The opportunities for photography during the transit of Venus will be greater than during an eclipse, and if two pictures are taken at a sufficient interval, the whole path of the planet might be calculated, and the chords described drawn, although the moments of contact might be lost from unfavourable weather. As to the accuracy of such photographs, an error of 1″ in the measures would only produce an error of two-tenths of a second in the parallax deduced. It only took the fiftieth of a second for a solar picture to be taken, and the click of the shutter gave an audible signal which could be used for noting the time. Mr. De la Rue gave some further details of the accuracy of such photographic results, and drew a diagram to illustrate the paths of Venus at two stations in 1874. Taking the pictures with the usual diameter of the sun at four inches, the displacement of the planet would be about one-tenth of an inch, from which the micrometer would give reliable measures. Messrs. De la Rue, Balfour Stewart, and Loëwy, had lately sent to the Royal Society a paper on ascertaining the amount of any optical distortion in the photographs of the sun, and had these means been applied to the eclipse photographs, the results would have been still better. A scale of equal parts, at the distance of a mile or more, is photographed, and shows by measurement any distortion producing unequal lengths due to the lens. It has been suggested that the collodion shrinks in drying, and thus alters the measures, but it has been found that such shrinking occurs in the thickness only. Experiments were made with ruled plates of glass covered with collodion containing specks for measurement, and no difference was found when wet or dry. Looking at Mr. Airy's charts, there appeared six stations, at which photography might be used. Equatorially mounted telescopes would be required, but neither circles nor driving clocks to them were necessary. The processes would be the same as practised every day at Kew, and there would be ample time for the operations, and none of the terror of losing the right moment inherent to the attempt to photograph the totality of a solar eclipse.

Mr. Stone suggested that if an altazimuth were sent out, it should be used to map down the position of Venus from time to time on the sun's disc, so as to compare with the photographs.

Professor Selwyn read a letter from Dr. Robinson, stating that he (Dr. Robinson) believed "in the next transits photography would play an important part," and said he was glad to find his views of the utility of such operations confirmed by that venerable astronomer.

The Astronomer-Royal said, that the relation of the introduction of photography to observe transits might be as important as the employment of telescopes, and might throw light on the curious phenomena of distortion, as the planet approaches the sun's limbs. These are probably due to irradiation. Now, irradiation must be telescopic or nervous. If the former, the effect will be photographed, but not so if due to the latter cause. This may introduce confusion into the comparison of observations made by photography with eye observations, and will require attention.

Mr. Huggins said, he rather thought that Professor Baden Powell's paper on Irradiation mentioned that it became apparent on a photographic plate.

The Astronomer-Royal: The subject is of great importance, and it is a pity it was not thought of three months ago, and the transit of Mercury photographed.

Mr. Stone said, that Mr. De la Rue had stated the displacement of Venus would be about one-tenth of an inch on the pictures, but the measures required to be made to $\frac{6}{10000}$ths of an inch to compare with eye observations. The photographs might still be valuable in other respects, but observations of the time gave the data required on a much larger scale. As to the observations of 1769, they have been thrown into confusion by not relying on the words of the observers themselves, and not distinguishing between the formation of the ligament and actual contact of limbs. Some of the observations thus not agreeing, were set down as forgeries. The same thing will happen again unless each observer describes exactly what he records as the time of actual contact.

Mr. Browning: I suppose the breadth of the planet is accurately known?

Mr. Stone: No such measures are necessary. The observer can estimate the breadth of the ligament.

Mr. De la Rue said he found, upon examining the results of the eclipse photographs, that measures, equal in delicacy to those Mr. Stone required, were obtained.

Mr. Stone: In that case the photographic results will be quite comparable with the other observations.

Professor Selwyn thought a longer exposure than one-fiftieth of a second would be required to depict the dusky edges of the sun with sufficient definition.

On the Transit of Mercury: by Mr. Browning.

The author exhibited a drawing, and also a large diagram of the planet as seen on the sun. The small drawing was the more accurate, the larger one being rough for viewing from a distance. They showed two small white spots upon Mercury, which Mr. Browning stated he had seen and drawn before hearing Mr. Huggins mention the spot he had seen at the last meeting. Two spots appeared to him to be present, but he doubted whether this was not due to the boiling of the sun and the retention of the impression of one spot on the excited retina during the oscillations, causing the spot to seem double. The aureola, seen by Mr. Huggins, was also visible to Mr. Browning and drawn. Since writing his paper, he had seen Mr. Pritchard, who assured him the white spot was merely an optical effect, as the shadow of a black disc held in front of a very luminous body is white in the centre.

The following papers were announced as received, and their reading deferred until the next meeting:—

The Transit of Mercury: by Mr. Talmage.

Observations of Meteors, November 14, 1868: by Sir E. Belcher.

Observations of the Meteoric Shower of November: by Professor Grant.

Ephemeris for Observations of the Physical Features of Mars at the opposition of 1869: by Mr. Marth.

Further Paper on an Automatic Transit Instrument: by Mr. Kincaid.

Elements of newly discovered Asteroids: by Mr. Watson.

Observations of the Solar Eclipse of 1868: by Mr. Chery.

Report on the Eclipse of August 1868: by Major Tennant.

On a defective Vision: by the same author.

On Meteors: by Mr. Kirkwood.

Measures of ζ Herculis: by Mr. Knott.

The Transit of Mercury: by the same author.

The meeting then adjourned.

ERRATA.—In last report, page 259, line 5, for *bright* read *rough*; line 19, for *one-sixteenth* read *one-sixtieth*.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

ETA ARGUS AND SURROUNDING NEBULA.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In your report of the Royal Astronomical Society's meeting for June last, you have recorded several circumstances named in the discussion, which require from me a reply. I am not at all surprised, notwithstanding the great care and diligence used by Sir John Herschel, at his failing to arrive at some identification by the means he took to compare the two drawings together. If that could have been accomplished, there would have been no use in observing and recording the apparent fluctuations taking place in the object. I am quite aware of the difficulty there is in establishing a system which subjects heavenly bodies to such variable and extraordinary changes. First, we have the star η, recorded for nearly two hundred years not exceeding the 4th magnitude; then, all at once, from 1862–3, it only reaches the 6th magnitude. Next we have it leaving the thick part of the nebula, and fixing itself within the dark space; then comes a complete alteration in the figure of the darker space, when compared with the Cape drawing, and which has, and I believe now is, gradually altering its character. These changes are accompanied with and followed by a dispersion of the stars and an increase of light. I may add to this last remark, that the object is distinctly seen in full moonlight, when all other nebulæ are shut out. With respect to my last drawing, which has been subjected to such important criticisms, it was never intended that it should be considered rigidly correct in the measures of all the stars; this exactness would not have affected the question as to the mutability of the object. Micrometers were first tried and rejected; the eye and hand drawing was preferred: this was done in an easy sitting position—the light obscured, except on the paper; the object conveniently situated, and the night brilliant. The drawing and object were compared together by the best artist in our survey office; besides which, I have all along had the concurrence of an amateur friend, whose eye may be considered only second to that of the late Mr. Dawes. Larger instruments and good observers are scarce in these colonies, and objects plentiful.

There is one other matter mentioned in your report that requires immediate reply. Sir John Herschel is made to say that, in reference to a passage quoted by me, *he had no recollection of it, and doubted whether it could be found in any of his published works.* It is to be regretted that this passage is not named. On referring to my notes I find only two quotations, and those, in all probability, would not have been used only for Sir John's own recommendation, in the "Results of Observations at the Cape of Good Hope," page 148, commencing at line 13—*Earnestly recommending*, &c.; also see page 640, section 871, "Outlines of Astronomy," 5th edition.

Yours truly,
FRANZ ABBOTT.

Private Observatory, Hobart Town:
September 10, 1868.

THE SUN'S DISTANCE.

Sir,—Your correspondent P. S. finishes a letter accusing Mr. Stone of appropriating, either intentially or unintentionally, results obtained before him by Professor Newcomb, of the United States, with the words, "What will the Americans say?" Had the Americans, one and all, no more knowledge of the matter in hand than your correspondent, it would be very little consequence to astronomers what they thought or said upon it. But it so happens that there are in the United States many astronomers of eminence, who, unlike P. S., take the trouble to inform themselves concerning a subject before they write about it. I imagine that many of your readers are aware that Professor Newcomb has never published any discussion of the transit of Venus in 1769. He has indeed written a paper of considerable value on the parallax of the Sun, as deduced from the observations of Mars in 1862. Comparing the result obtained with other determinations, he, in referring to the transit of Venus, was so far from re-discussing it himself, that he accepted the conclusion of Herr Powalky, which, however, as is well known, has not been considered satisfactory by astronomers generally, the process of arbitrary selection and attribution of different weights having been far too freely employed.

When Professor Newcomb saw Mr. Stone's truly valuable re-discussion of the observations of the transit of Venus in 1769, he wrote to the Astronomical Society, intimating his acceptance of it, and taking exception to one point only, the interpretation of observations of Chappe at the egress. Mr. Stone sufficiently showed, at the meeting at which this letter was read, the untenable nature of this single objection to a part of his investigation.

Your obedient servant,
W. T. L.

1868. Dec. 11.

THE PLANET JUPITER.

Sir,—As this is a favourable time for making observations on Jupiter, allow me to present your amateur readers with a pencil sketch of the markings on the planet, as seen on September 23, with my 12½-inch object-glass, of my own construction. Two white spots were observed, as shown, and on October 10 I observed an additional one, forming a triangle with the two shown on the sketch above and below the belt. On many occasions this season I have observed numerous dark patches much resembling the dark spot of a satellite crossing the disc. I hope to extend my observations on this planet, and bring out many of its finer markings and smaller objects, when I can erect an 18-inch object-glass in the place of my present one; I shall then offer my 12½-inch glass for sale to your readers.

Neptune, with its moon, was observed as an interesting object on the 10th instant. I have on several occasions seen one of Buckingham's comes to Vega; on the 10th I clearly divided Struve's small, close double star, situate near to γ Draco. This is a fine telescopic test. I would recommend your readers to try their telescopes upon it. The nebulæ are magnificent objects as seen by this large glass; numbers of them are clearly resolved into stars of the minutest points of light.—Yours truly,

Seager Street, Westbromwich: THOS. WHITEHOUSE.
October 12, 1868.

[In the sketch sent with this communication the white spots form a triangle situated near the centre of a faint belt which crosses the southern hemisphere of the planet about one-third of the distance from the South Pole to the Equator.—ED.]

Sir,—During the present and two preceding months I have very frequently examined Jupiter with my 4¼-in. refractor, and I send you some of the results, thinking they may interest a portion of your readers.

On several occasions I witnessed the rapid change of one or other of the belts. The most remarkable occurrence of this kind took place on the 18th of October, when a portion of the southern equatorial belt advanced from the edge of the planet's disc to the centre in about thirty minutes. At 8.15 on the evening in question, I noticed that the belt was much broader on the western edge than on any other part of the disc, and at 8.45 it had moved so quickly as to be near the centre. Such a rapid motion cannot be wholly ascribed to the rapid rotation of the planet. On October 21, at 6.50, the southern belt, although much broader, was not nearly as dark as the northern one, while at 9.25 it was notably the darkest. On October 17, at 10.53, a small belt was distinctly visible, over the south pole, which could not be discerned an hour previous. Other changes in the form of the belts were observed on several subsequent occasions, but these were, no doubt, the effects of the planet's rotation round its axis.

I have seen numerous transits of the satellites and their shadows, but have not succeeded in detecting any of the former as dark spots on the planet's disc. They appear very bright until after complete ingress, when they gradually fade and become indistinguishable, and remain so until they are near the opposite edge of the disc, when they again assume the appearance of a bright spot.

Dark spots appear to be of very frequent occurrence on the equatorial belts. On October 11th, 18th, and 21st, and November 23rd, one or more were distinctly seen. On the latter occasion, two were perceptible on the southern belt, one of which was so dark, that it could well have been mistaken for the shadow of one of the satellites in transit. This spot was of an elliptical form, and moved across the disc with great rapidity.

Later in the same evening, a dark patch became visible on the western portion of the northern belt, and on nearing the centre of the disc it lengthened considerably. As it approached the opposite edge it gradually assumed its original appearance. The other spots visible on October 11th, 18th, and 21st, were very minute, and could only be discerned after a careful examination of the disc.

Perhaps Mr. Buffham, or any other of your readers, will give me the results of their observations of the transits of the satellites.

I am, Sir, yours truly,
Ashley Road, Bristol: Dec. 15, 1868. WILLIAM F. DENNING.

JUPITER'S SATELLITES, OCCULTATIONS OF STARS, &c.

27 Oct. 1868.	I Sat. Ec. Reap^{ce}	6	7	54·8	GMT
2 Nov.	II Sat. T. I. first contact	6	51	51	
	last do.	6	59	8	
4 „	II Sat. Ec. Reap^{ce}	5	32	46·8	
9 „	II Sat. T. I. first contact	9	11	2	
	last do.	9	18	26	
	I Sat. T. I. first contact	9	35	57	
	last do.	9	42	17	
10 „	I Sat. Oc. D. first contact	6	46	35	
	last do.	6	51	49	
11 „	III Sat. Oc. R. last contact	6	8	9	
	I Sat. Tr. E. first contact	6	12	42	
	last do.	6	19	1	
	I Shad. E. first do.	7	6	7	
	last do.	7	10	40	
	III Sat. Ec. Disap^{ce} ±	7	20	48*	
	II Sat. Ec. Reap^{ce}	8	8	28·6	
	III Sat. Ec. Reap^{ce}	9	54	8·8	
26 „	I Sat. Ec. Reap^{ce}	8	19	28·5	
3 Dec.	I Sat. Oc. D. first contact	6	40	6	
	last do.	6	44	37	
	I Sat. Ec. Reap^{ce}	10	16	4·4	

Occultation of Stars by the "Moon."

28 Nov. 1868	*f* Tauri.	D.	7	9	56·8	GMT
		R.	8	4	53·5	
3 Dec. „	*d*^{2} Cancri.	R.	9	4	15·6*	

JOHN JOYNSON.

Waterloo, near Liverpool.

* Hazy cloud about the moon on each occasion.

THE ECLIPSES OF JUPITER'S SECOND SATELLITE.

Sir,—In the *Astronomical Register* for May 1864 you kindly inserted a notice from me, pointing out a curious oversight committed by some of our most eminent writers on elementary astronomy. I stated that in the works I had met with, the following authors, Brinkley, Woodhouse, Maddy, Sir J. Herschel, Mrs. Somerville, Malkin, and J. R. Hind, all assert, that "in any single eclipse" of the second satellite of Jupiter "*both* the immersion and emersion can never be observed." On the other hand, I pointed out that "the explanation of the articles in the *Nautical Almanac*," at the end of the volume, contains the true statement, thus—"It is seldom, also, that the disappearance and reappearance of the second satellite can be observed at the same eclipse; but both phenomena are generally visible with the third and fourth satellites." The following authors whom I have consulted agree with this statement, Vince, Inman, Admiral Smyth, Rev. T. W. Webb, and the Penny Cyclopædia, article "Jupiter." It is so seldom that both the immersion and emersion can be observed, that I have been looking out for the phenomenon for some years, but owing to unfavourable weather just at the critical time, or unavoidable engagements, I have never had the opportunity till last July. On referring to the *Nautical Almanac* of this year, it will be seen that on July 13th and again on July 20th the second satellite is eclipsed, and reappears, and is visible at Greenwich some quarter of an hour before being occulted by the planet. Thus, on July 20th the second satellite is eclipsed about 12h. 16m., reappears about 14h. 46m., is occulted about 15h. 0m., and emerges from behind the planet about 17h. 28m. I had the good fortune to observe this eclipse on July 20th, a beautiful summer's morning. I made the observation with my equatorial by Simms of 4 inches aperture and power 120. Counting the beat of my pocket chronometer, I first caught sight of the satellite on its emersion from the shadow at 14h. 47m. 23s·0. I then watched the satellite till the occultation, which took place at 15h. 0m. 38s. by the same chronometer. In this case, the satellite was shining out between the planet and the shadow during 13m. 15s.

The interval would doubtless have been longer, had I taken the precaution of shutting out the overpowering light of Jupiter, by using the small field of Mr. Dawes' solar eye-piece, as the satellite emerged so near to the planet's limb as to render the observation rather difficult and uncertain. I observed the occultation with great comfort, by employing the solar eyepiece and small field with power of 108. The observation was very interesting, as it was curious to watch the satellite emerge from the shadow, so close to the limb of the planet.

It is a singular oversight (with the greatest deference be it spoken) that Mr. Hind, in his "Introduction to Astronomy," 3rd edition, page 100, should have contradicted the statement (and the predictions too) in the *Nautical Almanac*, brought out under his own superintendence. I was much struck with the marked visibility of the satellites in the opening dawn. At 15h. 26m., when the light was so strong as to obscure all the fixed stars, Jupiter alone being visible to the naked eye, and when outside of my little observatory I could easily see to read the figures of the *Nautical Almanac*, the three satellites (the second being occulted) were distinctly visible in the finder of the equatorial, only of $1\frac{3}{16}$ inch aperture, which at night only in general just "glimpses" such of the satellites as happen to be near their greatest elongation.

Before concluding, I may mention that I had the good fortune to witness the daylight meteor, of which so much has been said in the public prints. I was so much surprised that I did not make any observation which might be of use in determining its position. It had all the appearance of a rocket, only the head, which seemed to be in a state of intense ignition, was much larger than any rocket I ever saw. It seemed to be moving parallel to the horizon, and in the same direction as the gale then raging, namely due west. By my chronometer the apparition took place very nearly at 3h. 16m. 0s. G. M. T., and from an experiment I made in the house before my impressions faded, I estimate the tail could not have been less than ten degrees in length. It would have been a superb object in a dark night.

I remain, Sir, yours truly,
GEORGE HUNT.

Chad Road, Edgbaston:
November 12, 1868.

P.S. When I made the above observation of Jupiter's satellite, I had not, owing to unavoidable circumstances, taken any transits for some time, and therefore did not know the exact error of my chronometer; but this is immaterial, as my object was to observe the interval of time between the reappearance and the occultation.

Sir,—I happened to be observing the Satellites of Jupiter on October 2, the evening referred to by your correspondent Mr. Gould; and I find that I have noted the error in the *Nautical Almanac* with regard to the position of the 3rd satellite. The *Almanac* is a witness against itself in this case; for it will be seen from the table of occultations, transits, &c., that the 3rd satellite was to enter upon the planet's disc at 21h. 15m., consequently must have been on the *east* side at 12h. 30m. The positions of this satellite appear to me to be inaccurately marked for two or three days about that date. It is placed manifestly too much to the west on October 3, and not sufficiently to the east on October 1.

Yours faithfully,
Nov. 13, 1868. R. P. D.

JUPITER.—In answer to R. J. Gould, I did not observe Jupiter on October 2; but a little examination of the configurations of its satellites in the *Nautical Almanac* about that date, will show that the third satellite is put in the wrong place from the 1st to the 4th.—T. W. B.

TEST OBJECTS.

Sir,—Will any of your correspondents kindly inform me if more difficult tests have been done (with equal apertures) than those mentioned below.

And oblige yours truly,
Broad Oak House, Westbury-on-Severn: W. J. H. BEECHEY.
December, 1868.

With my 3⅛-in. Achromatic (clear aperture), by Messrs. Solomons, Albemarle-street, I have seen,

11 Monocerotis trip.
12 Lynxis . . trip.
72 Cassiopeæ. trip.
Comes to Vega.
36 And. elong.
The quad. 4 & 5 Lyræ and the debilissima.
Comes to Aldebaran.

The parallel belts of Jupiter to either pole.

The craterlets 13, 14, 15, of the crater row in Area IV. Aζ of *the Lunar Map*.

With my 6½-in. Browning-With Reflector, I have seen,

γ^2 And. notched.
μ^2 Boötis, elong.
Comes (once) to δ Cygni.
η Coronæ dup.
ε. Equulei trip.
2 Comes to Vega.
5th Star in the Trapezium.
2 Comes to Polaris.

The shadow of Jupiter's 3rd satellite *smaller* than the satellite.

The craterlets 13, 14, 15, 18, 95, 22, 21, the dimples 8 and 9, and the pass 2† in Area IV Aζ. of the Lunar Map.

COMPANION TO ALDEBARAN, &c.

Sir,—As Mr. G. J. Walker observes, the companion to Aldebaran is not at all a difficult object, even for small telescopes. During the present season I have examined Aldebaran repeatedly, and I find that on any favourable night my 3½-foot Dollond, aperture 2¾ inches, shows the attendant clearly. In this as in other cases, a pretty high power eye-piece may be used with advantage. If W. J. H. B. can pick up the companion, he must see that the angle is correctly given by Webb, 35°·9.

Proctor, in his "Half-Hours with the Telescope," says that with a smaller aperture than 3 inches only three stars are visible in the trapezium of Orion. This is a mistake, as a small telescope, aperture 1⅝, in my possession, shows four stars with a power of about 40.

I hope, Sir, that no amateur will be deterred from turning his telescope on objects which some authors might lead him to think were far beyond its reach, as, after all, it is the eye that sees.

Yours very truly,

Carnlough, Dec. 12, 1868. J. R.

THE TRANSIT OF MERCURY.

Sir,—I did not send you any notes of the transit of Mercury in time for the present number of the *Register*, because many others would probably do so, and much better than myself; but after reading the very interesting reports by nineteen observers, presented in the December number, and noting that they all used achromatics, and that the majority saw the distortion of the planet at internal contact, it has occurred to me that perhaps the testimony of a reflector might be useful in the way of comparison.

I had a fine opportunity of observing the phenomenon, which I did in a darkened room, by projection on a sheet of the finest white pasteboard, in this obtaining an image of the sun 30·5 inches, and of the planet, ·08 of an inch in diameter. The atmosphere was very clear, evidenced by the steadiness with which the mottling of the sun's surface and the penumbræ of several spots were visible.

The planet's disc was very black, peculiarly different from the colour of the solar spots. It was uniformly dark, no spot on its surface being at any time apparent, but I saw it the whole time surrounded by an annulus of grey light, which had a very sharp boundary, and which on measuring, proved to be about one-sixth of the planet's diameter in width. Even after internal contact the annulus was as visible round that portion of the planet which was on the sun's disc, but not the slightest appearance of distortion of the planet's image took place.

It would be interesting to learn what others who observed with reflectors, or by projection, have to say on these three points—the bright spots, the annulus, and the distortion.

The time of passing off the disc was noted by my sidereal clock, which had been carefully corrected by several transits on the previous evening, but it was very difficult to say to one or two seconds when the last contact really took place.

Last internal contact	9h.	0m.	13s.
Appeared bisected	9	0	59
Last external contact	9	2	6

The instrument used, a silvered glass Newtonian, 8 inch aperture, with Ramsden eye-pieces, powers 90 and 160.

I am Sir, respectfully,

Brighton, December 8, 1868. HENRY PRATT.

PRISMS AND FLATS FOR REFLECTORS.

Sir,—Frequently annoyed by accidents to, and deterioration of, the film of the small flat of my reflector, I procured, about six months ago, a rectangular glass prism of 2½-in. aperture, from Steinheil of Munich.

Mr. Bird, the agent for Steinheil, has requested me to state my experience of it in the *Register*, and I have now much pleasure in doing so.

I find, by its use, a perceptible gain in light over the finest and most perfectly silvered flat, and, of course, a very considerable gain over a flat that has become tarnished. (The flat necessarily near the mouth of the tube is much more liable to tarnish than the mirror.)

In a word, it is always ready, always reflects the maximum of pure white light, and there is no trouble in re-silvering.

Mr. Lassell used to find his prism liable to dew, but (probably from mine being in an observatory, and my tube not an open one as his was), I never found mine so, the mouth of the tube acting as a dew-cap.

When I add, that the definition is equally perfect with that of a most beautiful flat by Mr. Browning, I am sure that I cannot more highly recommend the general use of the prism.

Yours faithfully,
DAVID GILL, jun.

48, Skene Terrace, Aberdeen:
November 23, 1868.

REFLECTORS AND REFRACTORS.

Sir,—As the discussion which has been commenced in your pages relative to the comparative merits of achromatics and silvered reflectors is one of some practical interest, I shall feel obliged if you will allow me space for a few remarks, the object of which is not so much to express my own opinion as to enable others to form an unprejudiced and correct judgment for themselves.

1. In the first place, permit me to observe that the question of the comparative light of these instruments has never been properly investigated. There is not, as far as I know, any published result except that of Steinheil, adopted by Sir J. Herschel in his treatise on the telescope, which gives 0·824 of the incident light for the effective portion. This must, I think, be too high, as it approaches very nearly to the effective light of an achromatic, 0·838, as there computed by Fresnel's formula,* or 0·89, as given by a mean of Sir W. Herschel's and Lambert's experiments. It might not unnaturally be supposed that, as I have an excellent specimen of each in my possession, I might have undertaken this determination. My little observatory, however, is not suitably arranged for the purpose, as it commands no distant terrestrial object, by means of which I believe the result would be best obtained; nor will it admit of the juxtaposition of the instruments, and, were it otherwise, I have not leisure for the multiplication of experiments which, in the confessed uncertainty of photometry, would be desirable in order to eliminate the sources of disturbance. I hope, therefore, that the enquiry may be taken up by some one more capable of bringing it to a successful and final issue, to which future appeal may be confidently made; and as my own little contribution to it, I would beg to offer the following suggestions.

---

* This result, however, is not quite satisfactory, as it is deduced, not from the refractive indices of both kinds of glass, but from that of crown glass alone. Another oversight occurs shortly after, where the two *perpendicular* reflections at the surfaces of a diagonal prism are not taken into consideration.

I believe that the most effectual mode of comparison would be to view with the same magnifying power a distant object as it gradually fades in the evening twilight, and to reduce the aperture of the instrument in which it is most readily seen, till the images are sensibly of equal brightness. The frequent repetition of the experiment, as the object becomes less distinct in the increasing gloom, will afford an excellent method of testing and correcting the first approximation; and in addition to this advantage, the stability of a terrestrial object in the field gives an unquestionable preference to this method over that of observing minute stars as tests of light. It will be necessary to attend previously to the magnifying power, which must be rendered the same in each instrument; and this, I need hardly say, will not be obtained by using the same eye-pieces, except in the case of equal focal lengths. The construction also of the eye-pieces ought to be similar. A number of gradually diminishing diaphragms of pasteboard or metal will, of course, have to be prepared, and the object-glass of the refractor should have suspended in front of it a small opaque disc, equal to the shorter diameter of the plane mirror in the reflector, and, therefore, intercepting an equal amount of light. Without this precaution the comparison will obviously be unfair, and the result worthless.

2. As regards definition, tested by the division of close double stars, much uncertainty has been introduced by the employment of changeable tests; and such, I need not say, is the character of many binary pairs. The assertion, for instance, in p. 228 of your last number, that a 7-inch refractor has "lately" clearly divided η Coronæ, is by no means a compliment, as was evidently intended, to that instrument. Since Smyth's measure, 0″·5, in 1852, it has been widening so much that in 1863 I could divide it with my 5½-inch achromatic, with a power of only 170; last year it was measured by Knott at 1″; it is now split by a 4½-inch silvered glass reflector, and has ceased to be a test for larger instruments. A list of objects combining relative fixity with progressive difficulty, both in regard to light and definition, would be valuable for the purpose of either absolute or comparative testing; the catalogues carefully prepared by Smyth are no longer accessible, excepting to the fortunate possessors of his "Cycle," and even those contain many changeable and consequently unsuitable objects. ζ Boötis is an admirable test, but now invisible; at the present season I would mention γ^2 Andromedæ for first-class instruments, which my 5½-inch achromatic could only elongate, but my 9⅓-inch mirror divides perfectly in suitable weather. η Orionis, which will soon be in sight, is very fixed about 1″, and a fine test, but too near the horizon. For smaller telescopes 36 Androm. has widened into a very suitable object, as it measured 1″·3 two years ago.

3. We have to bear in mind in such comparisons that not only some eyes will succeed, while others fail in detecting separation, but that a different opinion as to which is seen will be formed by different observers. The elongated disc, or wedge, which is the approach to division, will, with increasing power, be crossed by a dark line due to optical interference, before the two discs are seen, each distinct and uncompressed, with an interval of black sky. The former our great observer Dawes would not admit to be true separation; but it has probably been in many instances accepted as such, and hence much discrepancy may have been occasioned.

4. Attention should be directed to the fact that on stars the mode of definition in the achromatic differs considerably from that of the reflector. I believe at the same time that the process of "disking" the centre of the object-glass, which I have recommended, but of which I have no personal knowledge, removes much of the dissimilarity. It is well, however, to

remember that neither the neat but expanded disc of the achromatic, nor the smaller but more ringed and radiating disc of the reflector, is a faithful picture of the object. Each is but an illusion. An object subtending less than a certain magnitude can never, from the theory of light, form an image distinguishable from the effect of interference, and it is, therefore, not too much to say that no one has ever yet seen the real picture of a star, though the larger and more perfect the telescope the nearer is the approximation.

5. It may be added to the above considerations that achromatics of considerable size are by no means free from the "flare" so frequently complained of in reflectors. For this remark I am indebted to the eminent optician Alvan Clark, who ascribed it to the unequal cooling, from radiation, of the upper and lower portions of the tube, and recommended for its cure an arrangement for turning the tube round in a cradle, or the addition of a bright tin shield all along its upper part, but not in contact with it.

6. It should be borne in mind that in many cases, perhaps the majority, the real question is *not* which of the two kinds, having equal apertures and powers, is in all respects the nearest to perfection, but in which the amount of work that can be accomplished bears the largest proportion to the expenditure.

In the hope that the foregoing remarks may lead to a more thorough investigation of the question, and may conduce to the formation of a fair and unprejudiced judgment,

I remain, Sir, yours faithfully,
Hardwick Vicarage: Nov. 2, 1868. T. W. WEBB.

Sir,—I am sure your readers will have read with interest the extracts from the *English Mechanic* on this subject in your last number; at the same time, it appears evident that both the correspondents quoted have a decided partiality each for his own favourite instrument, and the statements on both sides appear much exaggerated.

The statement that reflectors exceed refractors in light-grasping properties, is manifestly an error; since Browning states it requires a reflector of $\frac{1}{6}$ greater aperture to equal an achromatic, and, in practice, I find my 6½-in. mirror about equal to a 5½-in. object-glass. The same correspondent says: "all this, combined with the comfort and ease of observing, will prevent my ever using refractors, except as finders or transits." Apart from these two statements (which we may charitably suppose to have been penned during a feeling of very pardonable exultation, at the successful completion of what must have been a work of considerable labour and anxiety), there is nothing amiss in the letter of "Beta Cygni." On the contrary, a man who can successfully grind his own mirrors, and then mount and turn them to good account in observing the heavens, must be gifted with a large share both of skill and perseverance. So much for Beta Cygni.

In the letter of "61 Cygni" I think we see statements quite as erroneous as those just mentioned; thus, after mentioning the performance of various excellent achromatics of from 2·2-in. to 3¾-in. aperture, and saying that the latter size, by Dollond, showed the minute companion of α Lyræ on favourable occasions, assisted by a little patience, he says that they must be equal to the 6½-in. mirror: this is a very great mistake, since, in a mirror of that size, with a power of 150, the companion of α Lyræ is a conspicuous object; indeed, it is but 11 magnitude. The companion of α Serpentis, dist. 50″, which Smyth, with his $5\frac{9}{10}$-in. object-glass calls very delicate and rates 15th magnitude, is seen without much difficulty in my mirror.

Few observers will agree with him that powers above 200 are of no advantage in planetary observations, since we know that a good achromatic object-glass will bear a power of 100 for every inch of aperture. I employed a power of 200 with advantage in delineating the markings on Mars at the last opposition, with an object-glass of 2 inches aperture; and such powers as 120 or 170 would not satisfy an observer who wished to draw the details of Saturn. The assertion of Dr. Kitchener ceases to have any weight in the present advanced state of the science of optics, since numbers of telescopes are now to be found of a size and perfection unknown in his day. The remark, "that to obtain fine views of the planets, large apertures and low powers are required," shows a deficiency of practical knowledge, a certain proportion of power to light being necessary for the perfect observation of most celestial objects; a low power, with a considerable aperture, would give so much glare from excessive illumination as to obliterate many planetary details which would be successfully observed when the light is modified, by the application of considerable magnifiers. On the judicious employment of various powers, according to the condition of atmosphere and object to be observed, depends the success of astronomical observations.

A reference is made to the liability to tarnish of the specula of reflectors. I have used some metal reflectors of considerable age (one by the celebrated Short), whose lustre did not seem the least impaired. Those of silvered glass are stated to retain their brilliancy three or four years. My 6½-in. mirror shows no perceptible diminution after eighteen months' continual work; but the plane is considerably tarnished, at which I am surprised, since both, being in the same tube, might have been thought to be equally affected. The continued efficiency of any telescope depends in a great degree on the care with which it is used, and carefully guarding it from damp and dust when not employed.

Yours very truly,
Chesham: October 26, 1868. CHARLES GROVER.

THE HARVEST MOON.

Sir,—If we agree to reject the claim of October to a harvest moon, the field of discussion is so far narrowed. I have tabulated for a metonic cycle the dates of the September and October full moons, from 1851 to 1869. An examination of this table shows that the common way of reckoning the harvest moon, and the precept given by Mr. Chambers, lead to the same result in ten cases out of nineteen. That is to say, the full moon nearest the autumnal equinox also precedes it in these instances. In four other cases Mr. C.'s rule would be preferable to the other, which carries the H. M. into the first week of October, beyond our assumed limit. The remaining five cases are more doubtful—the full moon falling from 24th to 30th September; but the preference might still be described by Mr. C.'s rule, inasmuch as, in general, the H. M. might be considered better placed late in August than late in September.

As the designation originated with agriculturists, if the H. M. had been marked in their calendar during this cycle, according to Mr. C.'s rule, they would, probably, have found it sufficiently *en règle*. Nevertheless, to avoid taking a liberty with the purely astronomical criterion, it seems better to abide by the ordinary definition of the H. M., and to supplement it by observing that, when falling very late in September, or in the beginning of October, the full moon preceding will practically deserve the preference from the husbandman's point of view. The account given in *Once a Week* is very well, saving the flippant allusion to final causes which, let us hope, the writer will regret. It is clear that, though there is only one astronomical H. M., there are not unseldom two successive full moons, each of which may be, practically, a H. M., to the S. and N. parts of the kingdom respectively, and each would be the H. M. *par excellence* to those benefited by it. That the proper equinoctial H. M. is not equally beneficial in all years, any more than the harvest itself is always equally plentiful, is no disparagement to the goodness which bestows the one and ordains the other. In the event of a late and unfavourable season, the full-orbed September moon, quite late in the month, at once replacing the setting sun and shining in successive evenings over the closing operations of a hard and perhaps anxious day's toil, may be really a better-timed and more welcome auxiliary than its predecessor a month before, when the daylight was longer, and work less pressing.

It seems that the Indians of the Upper Mississippi have their *wild-strawberry moon*, *wild-rice gathering moon*, *leaf-falling moon*, *deer-rutting moon*, and *ice-moon*. Against this rather copious *lunar* phraseology, our Saxon forefathers appear only to have had their harvest and hunters' moons to set off; though it may be thought they made up for this paucity by their *honey-moon*, of indefinite frequency (attendant rather upon Aphrodite than upon Demeter or Artemis), which, though not observed now exactly as in the ancient manner, still may be allowed, in a more limited sphere, to excel all other moons in its hilarious and inspiriting associations!

Yours faithfully,

November 10. GEORGE J. WALKER.

Sir,—The harvest moon is not out of time, but the time has outrun the harvest-moon. A few words on the subject may not be out of place.

The apparent irregularity of the harvest moon is caused by the misrepresentation of Newton, who states the Earth to be 365 days, 6 hours, 56 minutes, 4 seconds annually going round the Sun, being 6 hours, 56 minutes, and 4 seconds longer than the daily time of the year; thus making in 4 years, 27 hours, 44 minutes, and 16 seconds, out of which Newton takes 24 hours (without saying anything of the other 3 hours, 44 minutes, and 16 seconds) and adds the 24 hours as the 29th of February, making Leap Year, which otherwise would be the 1st of March. Since the time of Newton, in 1724, there have been 36 leap years, consuming the whole of March and part of April; consequently, the 6th of April in 1724 would become the 1st of March in 1868; carrying March to April, April to May, May to June, &c., while the standing order of nature has kept its position. Therefore, what was the harvest moon in September 1724 is now the moon in August 1868.

If the Earth had a rotary motion from west to east, the western hemisphere of the forenoon would be the eastern in the afternoon.

I am, Sir, yours, &c.

Godalming, Surrey: THOMAS F. JACKSON.
Oct. 19, 1868.

MÄDLER ON THE MOON.

Sir,—The acknowledged impartiality with which you admit the freest and unbiassed examinations of all questions connected with Astronomical science, is my apology for obtruding on the notice of your readers the following observations on the paper by Professor Mädler on lunar changes, published in No. 71 of the *Register*. In his opening remarks, the Professor clearly admits the *continuance of the operation of forces* capable of working changes in the Moon to which I may presently refer. With regard to *bright* spots on the dark side of the Moon, Mädler refers them to the very centres *Copernicus* and *Kepler* and the bright mountain Aristarchus. The pages of the *Register*, however, testify to the existence of bright spots in other localities, which cannot be referred to *earth-shine*. From the Professor's remarks on Schröter it would appear that his seleno-topographical fragments are next to useless. I have been in the habit of using them during the last ten years, and take this opportunity of placing before your readers the value I am disposed to place on them. So far as the construction of a map is concerned, I quite agree with Mädler that they are inadequate, but as sketches of the appearance of objects at epochs, varying from 65 to 80 years since, they appear to be *invaluable*. As drawings they are rude, but the descriptions which accompany them, and the reference letters which are appended to the craters, mountains, and principal objects, form a mass of evidence *which ought not to be forgotten*, but which should be consulted on every available occasion, *for an object which appears in the drawing and is referred to in the text* must have had at the time a veritable existence, no matter whether the observer misunderstood its nature or not; there it was to be seen and recorded. It is not a little remarkable that the more recent drawings are destitute of these important helps, which, as time rolls on, will greatly impair their value. If, as Mädler remarks, "changes are still working," how can our successors in time to come determine a change, if there be uncertainty about the drawing? It may give the general effect of "*appearance*," but it is in the *minutest* objects that we must seek for "change." I have succeeded, on some occasions, in seeing objects of Schröter's drawings under similar conditions of illumination and libration, and can bear witness to the *exactitude* of those which I have so examined. In others I have recovered objects supposed to have been lost. With regard to colour, Mädler long ago remarked that the green tint generally appears only when the Moon is quite or nearly full. My experience is somewhat different to this. It is at early morning or late in the afternoon that I have generally seen the green predominate. Plato is a remarkable instance: a delicate green just after sun-rise; a blackish grey at noon, and again green just before sun-set. The study of colour as well as of shadow, with their varieties, is vastly important. On the employment of large telescopes I would make *one* brief remark; much, very much may be accomplished, especially by the united efforts of many observers with instruments under six inches of aperture, even in so changeable a climate as ours. In No. 65 of the *Register*, p. 109, "Reports of the Lunar Committee," I find mention made of thirty-two observers engaged in zone work (which is recommended by Mädler) and special studies. I have not met with a published statement of the results of their labours, but should anticipate that many of the objects in the British Association catalogue would receive valuable confirmation, and their condition be well settled for the present epoch. The work to be accomplished, as Mädler well remarks, is immense, and much of it consists in the determination of large and broad features which are well measureable by means of *small* instruments. The Professor's observation of *Linné*, on the 10th of May 1867, is highly important. Several observations were made the same evening, as appears from the report of the Lunar Committee, presented at Dundee (*Report British Association*, 1867, pp. 13, 17, and 18), which are not in accordance with the description by Mädler of *Linné* in 1831, as given in the *Register*, No. 70, p. 214. In the sections of the British Association map and in the catalogues accompanying, the coincidence of faults, mountain ranges, and light streaks, is pointed out. In the report presented at Nottingham (*Report* 1866, p. 268) it is said of two of the rays from Tycho, "Both rays traverse *uneven* ground, of the nature of cliffs, having their slopes towards the west," and the brightness of one is said to be much broken in passing over broken ground. An extensive fault (p. 255) is said to be coincident with the ray from Tycho, which passes through or along the west border of *Albategnius*, and also crosses the *Mare Serenitatis*. *Bessel*, as is well known, is situated upon this ray, which also coincides with the central ridge of the *Mare Serenitatis*. I have been informed that *Bessel* occurs on a break in this ridge, also that the streaks from Messier have been seen just at the time when the sun was setting on Messier. The shadows of the ridges and mountain ranges coincident with the rays are always very plain at sun-rise and sun-set. Taking Mr. Nasmyth's theory of the rays being similar to the cracks in a glass globe, burst by the expansion of heated water (see *Astronomical Register*, No. 18, p. 126), as explanatory of the production of faults, such as radiate from Tycho, may not some physical connection exist between them and the mountain chains, ridges, and broken ground capable of being elucidated by further observation? With regard to Professor Mädler's suggestion, relative to the observations of rills (clefts), I would refer to the *Register*, No. 65, p. 110, where a similar suggestion will be found by Mr. Slack.

Although I have pointed out the above passages in the Professor's paper in a somewhat critical manner, taken as a whole the paper is very valuable, and its bearing on researches into the physical aspect of the Moon's surface is likely to be very beneficial, especially as regards the subject of change, which appears to be more readily admitted now than formerly.

I am, Sir, your obedient servant,
G. W. A.

THE ASTRONOMISCHE GESELLSCHAFT.—Two meetings of this Astronomical Society have been held, both under the presidency of Professor Argelander, one in 1865 and the latter in 1867. The subjects discussed at the last meeting were—The construction of New Tables of Jupiter; Observations of Periodic Comets; a New Reduction of Bradley's Observations; Nomenclature of Variable Stars; Proposed Star Observations; and the Nomenclature of Minor Planets. The next meeting was appointed to be at Vienna in 1869. Besides a quarterly journal, eight other works have been published by this Society.

NAVIGATION AND NAUTICAL ASTRONOMY: by Merrifield and Evers. London, Longmans.—The rapid advances made in every department of science in the present day cause all works, not indeed to become obsolete, but to require fresh editions from time to time to bring them up to the necessary standard. This is the case with works on navigation and nautical astronomy, as with books treating of other subjects. Excellent as are the books of Norie, Raper, and others, there are yet points in them which require simplification, or a different treatment adapted to present requirements. We are glad therefore to see the work of Messrs. Merrifield and Evers, which seems very completely adapted to its purpose; the various explanations are given with regard to modern appliances and methods of observation, and the examples, worked out with strict reference to the *Nau-*

tical Almanac, are clear and to the purpose. Regard is also had to the examinations of the Science and Art Department of the Committee of Council on Education. The book, in short, which is well printed on stout paper, will be found most useful, not only to those preparing for a nautical life, but to all who are interested or occupied in astronomical observations.

Fomalhaut.—D. T. K. calls attention to α Piscis Australis, which, having suspected of duplicity, he has examined himself, and asked others to do so. The result does not seem to bear out his suspicion, but he observes a curious green colour in connection with the star. We imagine this arises from atmospheric causes connected with the low altitude of the star.

LIST OF SUBSCRIBERS—Names received since our last number.

Cunningham, G. Esq., 1 Old Hall Street, Liverpool.

Flemming, Rev. D., Vicarage, Coxhoe, county Durham.

Williams, J. M. Esq., Merton Villas, Merton Road, Bootle, near Liverpool.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To December 1868.

Dell, T.
Doncaster, C.
Harris, Rev. C. S.
Linwood, Rev. R.
Smelt, Rev. M. A.
Watts, Rev. R. R.

To March 1869.

Beechey, W. J. H.
Buffham, T. H.
Coulcher, W. M. B.
Flemming, Rev. D.
Forward, R.
Jones, Rev. T.
Williams, J. M.
Wright, W. H.

To April 1869.

Lewis, H. K.
Reside, J.

To June 1869.

Garnett, W.
Glover, E.
Gooch, Miss.
Jefferies, J.
Noble, Capt. W.

To December 1869.

Baldelli, Mdme.
Bates, T.
Cunningham, G.
Davies, Rev. R. P.
D'Alquen, F. M.
Ellis, W. M.
Gilby, J.
Glover, Rev. J. H.
Hall, Rev. R.
Jones, Rev. E.
Joynson, J.
Lee, J.
Perrins, J. D.
Tidmarsh, Rev. J. B.
Williams, G.
Walker, G. J.

December 21, 1868. Subscriptions after this date in our next.

NOTICE TO CORRESPONDENTS.

Several communications are delayed for want of space.

THE NOVEMBER METEORS OF 1868.

Through the kindness of Mr. W. S. Gilman, of Rockland, U.S., we have received the *Rockland Journal* of November the 28th, which gives a very interesting account of the magnificent meteor shower visible on the evening of the 13th of November, in the United States. The trail of coloured smoke left by one was observed for at least 40 minutes—during which time its changes of outline were most remarkable. One of the great features often displayed was the changes of colour in two different trains. We hope that advantage has been taken of the use of the spectroscope in the examination of these interesting phenomena.

The following are the numbers given of the meteors observed in the United States on this occasion:

Boston . .	during 3 hours	3,500	2 observers.
Williamstown .	„ 4 „	2,480	3 „
New Haven .	„ 6 „	7,000	12 „
Palisades, New York	„ 6 „	1,452	2 „
Albany, New York	„ 6 „	1,800	2 „
Washington .	„ 7 „	5,078	4 „
New York City .	„ 7 „	2,920	- „

The following notice of the meteors is from a correspondent of the *Guardian*, who, writing from Naples, says (after some allusions to the eruption of Vesuvius):—"Some of us (I fear but few, from the hour at which it took place) have been delighted, even to a holy awe, with a spectacle exceeding in splendour the fires of Vesuvius. I allude to the meteoric shower which was visible on the morning of Saturday, November 14. At half-past twelve at night I examined the sky carefully, and did not see a single meteor. The air was crisped by a north-east wind and the stars shone with a brilliancy unusual even in this climate. Jupiter in the zenith was doing the part of a moon, and its rays marked out a path of gold on the waters of the bay. At a few minutes after five I was awakened to behold a sight which, as I have said, was as solemnising as it was delightful. In every direction meteors were rushing over the sky, not singly nor in twos and threes, but literally in showers. They ran together and chased each other from all quarters of the heavens. My windows looked south-east, and these mysterious lights were to be seen shooting round about and apparently into Vesuvius in the east; they played over Capri in the south, they fell like arrows over the point of Posilipo in the west. Their movements were in all directions. They shot perpendicularly upwards and downwards, they ran at each other diagonally, and I saw several which travelled horizontally. Many of them were of exceeding beauty, both for size and brightness, and lighted up the room for seconds. Two, however, were extraordinary, both as to the body of light which they emitted and for the time of their duration. One in the north-east burst like a rocket, scattering a profusion of what I may call sparks of all colours. These sparks appeared to be wafted together into a dense cluster which floated in the sky for at least five minutes. I had watched it for some time, and then left the room to examine the sky from the back and side windows of the house, which commanded the west and north-west. I found the showers everywhere; and when I returned to the room I had quitted there was still the cluster, fainter and dying out, but visible and about the size of the Pleiades, for which at first I mistook it. A second meteor exceeding this in beauty burst on my sight as I was watching the expiring glories of the one just described. It was a globe of fire which made its appearance directly before me, midway, it seemed, between myself and Capri. It illumined the sky, already bright with stars, with these strange lights, and I may add with the fires of Vesuvius. From this globe there shot upwards and downwards perpendicularly what I must describe as rockets of the grandest description. These rockets trailed to a great distance in either direction, pouring out lights of all colours; blue and red, however, largely prevailed. These coloured lights hung in the sky some thirty or forty seconds, dying out much sooner than those of the meteor which left its traces for so long a time. I watched these beautiful phenomena until nearly six o'clock, when daylight fairly overpowered them. They did not seem to me, however, to diminish in number to the last moment."

ASTRONOMICAL OCCURRENCES FOR JAN. 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Jupiter —
Fri	1	 9 28 10 25 23 38	Sidereal Time at Mean Noon, 18 44 41·9 Occultation of α Leonis (1½) Reappearance of ditto Conjunction of Moon and Mars, 2° 0′ N.	1st Tr. I.	11 36	5 39·2
Sat	2	9 58 15 34 18 5 19 9 20 45	Near approach of Moon to χ Leonis (5) Conjunction of Saturn and Venus, 0° 15′ S. Occultation of σ Leonis (4) Reappearance of ditto Superior Conjunction of Mercury	1st Oc. D.	8 55	5 35·6
Sun	3	14 40 15 20	Occultation of 10 Virginis (6) Reappearance of ditto Meridian passage of the Sun, 4m. 54s. after Mean Noon	1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E. 2nd Oc. D.	6 5 7 26 8 21 9 40 10 31	5 32·1
Mon	4	18 22	☾ Moon's Last Quarter	3rd Sh. E. 1st Ec. R.	4 25 6 57 24	5 28·6
Tues	5			1st Sh. E. 2nd Tr. I. „ Tr. E. „ Sh. I. „ Sh. E.	4 9 5 37 8 11 8 19 10 46	5 25·1
Wed	6	18 9 19 16	Occultation of ξ^1 Libræ (6) Reappearance of ditto			5 21·6
Thur	7			2nd Ec. R. 3rd Oc. D.	4 56 47 10 9	5 18·1
Fri	8					5 14·6
Sat	9	1 35 17 9	Conjunction of Moon and Saturn, 3° 10′ S. Conjunction of Moon and Venus, 3° 20′ S.	1st Oc. D.	10 53	5 11·1
Sun	10			1st Tr. I. „ Sh. I. „ Tr. E.	8 2 9 22 10 18	5 7·7
Mon	11			1st Oc. D. 3rd Sh. I. „ Sh. E. 1st Ec. R.	5 22 5 49 8 26 8 53 16	5 4·2
Tues	12	6 53 22 21	● New Moon Conjunction of Moon and Mercury, 3° 40′ S.	1st Tr. E. „ Sh. E. 2nd Tr. I. „ Tr. E. „ Sh. I.	4 47 6 5 8 18 10 52 10 57	5 0·8
Wed	13					4 57·4
Thur	14			2nd Oc. R. „ Ec. D. „ Ec. R.	5 6 5 13 1 7 33 27	4 53·9
Fri	15					4 50·5

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Sat	16		Sidereal Time at Mean Noon, 19 43 50·3			Jupiter 4 47·1
Sun	17		Meridian Passage of the Sun, 10m. 9s. after Mean Noon	**1**st Tr. I.	10 0	4 43·7
Mon	18	13 17	Conjunction of Moon and Jupiter, 3° 6′ N.	**3**rd Tr. I. **1**st Oc. D. **3**rd Tr. E. „ Sh. I. **1**st Ec. R.	4 33 7 21 7 32 9 52 10 49 4	Moon — 4 24·0
Tues	19			**1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	4 30 5 46 6 45 8 0	5 6·2
Wed	20	12 26	☽ Moon's First Quarter	**1**st Ec. R.	5 18 4	5 49·4
Thur	21	6 1	Near approach of Moon to μ Ceti (4)	**2**nd Oc. D. „ Oc. R. „ Ec. D. „ Ec. R.	5 14 7 48 7 50 4 10 10 15	6 34·5
Fri	22					7 22·3
Sat	23	5 16 4 34 5 39 4 41 5 31 5 40 6 53 8 49 10 5	Near approach of Moon to 75 Tauri (6) Occultation of θ^1 Tauri (4½) Reappearance of ditto Occultation of θ^2 Tauri (4½) Reappearance of ditto Occultation of B. A. C. 1391 (5) Reappearance of ditto Occultation of Aldebaran (1) Reappearance of ditto	**2**nd Sh. E.	5 22	8 13·6
Sun	24	5 29 6 12 8 14 9 10 8 48 10 0	Occultation of 115 Tauri (6) Reappearance of ditto Occultation of 119 Tauri (5½) Reappearance of ditto Occultation of 120 Tauri (6) Reappearance of ditto			9 8·6
Mon	25	23 51	Conjunction of Moon and Uranus, 3° 15′ N.	**3**rd Tr. I. **1**st Oc. D.	8 50 9 20	10 7·0
Tues	26	13 26 14 29	Occultation of *g* Geminorum (5½) Reappearance of ditto	**1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	6 29 7 42 8 44 9 56	11 7·7
Wed	27	 13 30 17 30 18 14	Eclipse of the Moon; visible at Greenwich ○ Full Moon Occultation of o^2 Cancri (6) Reappearance of ditto	**1**st Ec. R.	7 13 47	12 9·0
Thur	28	17 0 17 56	Occultation of ν Leonis (5) Reappearance of ditto	**2**nd Oc. D.	7 59	Jupiter — 4 6·9
Fri	29	3 3	Conjunction of Moon and Mars 3° 13′ N.	**3**rd Ec. R.	6 17 2	4 3·6
Sat	30			**2**nd Sh. I. „ Tr. E. „ Sh. E.	5 34 5 44 8 0	4 0·3
Sun	31					3 57·0

THE PLANETS FOR JANUARY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date.	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	19 12 56	−24 21½	4″·6	0 12·4
	20th	20 59 21	19 0½	5″·3	0 59·6
Venus	5th	17 0 34	−21 33	12″·0	21 56·5
	20th	18 21 0	22 50	11″·4	22 17·7
Mars	5th	10 31 56	+13 8½	13″·4	15 28·9
	20th	10 25 53	14 17	15″·1	14 23·9
Jupiter	5th	0 26 25	+ 1 27½	37″·0	5 25·1
	20th	0 33 56	2 20	35″·3	4 33·6
Uranus	5th	7 7 10	+22 59½	4″·2	12 4·7
	21st	7 4 14	23 4½	—	10 58·9
Neptune	5th	0 56 10	+ 4 14½		5 54·7
	21st	0 56 48	4 19½		4 52·5

MINOR PLANET.—From the *Monthly Notices* we learn that the minor planet discovered by M. Coggia, at Marseilles, on July 16, would seem to have been independently discovered by Professor C. J. Watson, at Ann Arbor, five days previously.

ECLIPSE OF THE MOON.—A partial Eclipse of the Moon will take place on the 27th of January, at about a quarter-past 11 o'clock in the evening.

Greenwich Mean Time.

		H	M
First contact with the Penumbra, Jan. 27	.	11	18
,, ,, Shadow ,,	.	12	29
Middle of the Eclipse . . ,,	.	13	38
Last contact with the Shadow . ,,	.	14	47
,, ,, Penumbra ,,	.	15	58

Magnitude of the Eclipse (Moon's diameter = 1) 0·450.

The first contact with the Shadow occurs at 50° from the north point of the Moon's limb towards the east; the last contact at 31° towards the west; for *direct* image.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 74. FEBRUARY. 1869.

THE MARE SERENITATIS.

The very general interest that has been taken lately in the enquiry as to whether or not there are any changes at present going on in any part of the moon's surface has led to a more minute observation of the different craters, and parts of the moon where such change was supposed most likely to occur. Among these the crater "Linné" has attracted very considerable attention—it having been announced some time ago that some change had taken place in its aspect.

This crater, as is well known, is situated in the "Mare Serenitatis," where it forms the most noticeable object on the eastern side. We have observed it at various times, and have in consequence had our attention drawn to the other craters in the same "Mare"; we have therefore been led to observe the whole area, and the accompanying map is the result of our researches. The scale we have adopted is one-half larger than the "Map of the Moon" by MM. Beer and Mädler; but it was on that map we worked as our guide, and from it we have taken the names and letters attached to many of the craters. We have carefully triangulated all the principal craters, and laid them down from those measures; but the smaller craters are in general put in from eye observations of their positions in reference to the nearest large crater in their neighbourhood.

It is not needful that we bear testimony to the value of Beer and Mädler's map; but we cannot refrain from expressing our admiration of the correctness and extent of their work. Our endeavour has been to follow them, and in doing so we have taken what pains we could to put carefully down all the craters we could detect, and also some of the white spots which we believe may be craters, though not yet proved to be such. We say "some," for it would, we think, be well nigh impossible to map down correctly all the small white points that are at times very observable, particularly over the southern and south-western area of the "Mare." They are practically innumerable

—partly from their number, partly from their small size, but above all from their apparent similarity making it almost impossible to decide which was and which was not mapped. Those set down have been verified by several separate observations.

The "Mare" is bordered on the west and south side by a part darker than the general aspect of the centre. This border seems to descend in two or more terraces: each terrace being lower as it recedes from the hills towards the "Mare;" and in some parts they give an impression as though they had been formed by a wash of a sea on the shore. This is to our sight very observable on a similar border on the eastern side of the "Mare" where the hills open to the east of "Linné."

The well known "ridges" cross the "Mare" in general direction north and south. There are four principal ones beside the well marked "streak" that runs from "Menelaus" partly through "Bessel" on towards the northern boundary of the "Mare." This "streak" appears, in the part between "Bessel" and the crater marked *d*, to be formed of two very low parallel ridges. There are at times some streaks visible that seem to radiate from a point on the northern boundary opposite to the end of the main streak. We think they are connected with, if they are not another aspect of, the "ridges." They branch off towards the southern side, but, with the exception of the main streak, do not appear to reach it. There is a streak occasionally seen that runs from "Bessel" in a south-west direction, which is also formed of a double, very low, parallel ridge.

Both "ridges" and "streaks" change their aspect so much that it is somewhat difficult to map them correctly. Some ridges are crossed by others at various angles, and they are on the north-eastern area of the "Mare" a good deal interlaced, giving a curious aspect to it.

Most, if not all, of the craters, that are visible as such, have an appearance as if their walls had been suddenly raised above the surrounding part of the "Mare," and are round, as though a cylinder had been formed on the surface. They cast decided shadows, though many of them are not large enough to present a view of the central opening. The smallest craters seem to have a tendency to group themselves into festoons or curves between two craters of a larger size.

The general aspect of the "Mare" is throughout of a very uneven, irregular character, and varies much in shade of brightness according to the angle of illumination, and the state of our own atmosphere at the time of observation.

We had endeavoured to represent on the map the position of the lighter and darker portions of the "Mare," but found at last that it was undesirable to do so, owing to the fact of their constant variation.

JOHN JOYNSON.
Liverpool: Jan. 5, 1869. GEORGE WILLIAMS.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868-9.
Third Meeting, January 8, 1869.
Admiral Manners, *President*, in the Chair.
Secretaries—Mr. Stone and Mr. Huggins.

The President stated, in explanation of the *Monthly Notices* for December not having been issued, that it had been delayed by the preparation of the maps for the important paper of the Astronomer-Royal. It would also contain some illustrations of Mr. De la Rue's valuable paper, so that a few days' further patience would amply reward the Fellows.

The Minutes of the last meeting were read and confirmed.

Thirty-one presents were announced, including an interesting work by Schiaparelli on the identity of certain comets and meteors, and the thanks of the Society voted to the respective donors.

Rev. R. H. Blair,
Edward Clodd, Esq.
Captain C. T. Haig, R.E.
Powell Jeffreys, Esq.
James Knight, Esq.
Lieut.-Gen. Lane, R.A.
Alfred T. Smith, Esq.
Rev. S. Saywell,
Rev. J. White,
Lieut. Archibald C. Wither,

were balloted for, and duly elected Fellows of the Society.

The following papers were read:—

Report of the Observations of the Total Solar Eclipse of August 1868: by Major Tennant.

These observations were considered so important that both the Royal Society and the Royal Astronomical Society addressed the Council for the Government of India, and obtained a promise of the necessary funds for the purpose. It was desirable that observations should be made with the spectroscope on the red prominences, with the polariscope on the light of the Corona and the prominences, and that photographs of the totality should be obtained. It had been originally intended that Major Tennant should take the photographs and Lieutenant Herschel observe with the spectroscope, but the Royal Society having subsequently determined to send an expedition on its own account, which was placed under the charge of Lieutenant Herschel, the spectroscope observations of the original expedition were undertaken by Major Tennant himself, while the photographs were entrusted to Sergeant Phillips, R.E.

The report was divided into the following sections:—

1, Personal narrative; 2, astronomical determination of the position of the station; 3, the equatorial spectroscope; 4, the polarising telescope; 5, the photographic telescope; 6, the results. Division 1. The proceedings of Major Tennant up to his departure from England have been already reported in the *Monthly Notices.* He arrived at Aden on January 25th, 1868, and, finding some friends there, requested them to make observations. He recommended drawings of the phenomena should be obtained, and that, if possible, two independent drawings of the same part of the eclipse should be obtained rather than attempting to draw the whole of the objects visible. He sent these gentlemen Savart's polariscope, and addressed Mr. Huggins with the view of two hand spectroscopes being forwarded to them, but has not yet received any results. Passing onwards, he stopped at Madras to make enquiries as to the weather, and received rather depressing accounts of the quantity of rain and cloud that might be expected. In March the spectroscope equatorial arrived, and some of the photographic apparatus, much of the latter being damaged and broken. Early in May the silvered glass mirror for photographing arrived. The cases were much damaged, but the injury to the instrument was not so great as might have been expected. All the available resources of the workshops were at once applied to the necessary repairs, and in June the expedition was ready to start. Division 2.—These observations were not read. Division 3.—The telescope used for the spectroscope observations was the R.A. Society's Sheepshanks instrument No. 3, of 4·6 inches aperture, and 5 feet focal length. The equatorial mounting was by Cooke, and the polar axis had been altered for the low latitude, but the clock prevented the telescope being reversed. Proper counterpoises had been attached for use with the spectroscope. The latter was one made by Mr. Simms, for Greenwich observatory, and contained only one prism, and had no cylindrical lens for observing star spectra. A photographic scale, illuminated by a lamp, was used to identify the lines, and means of altering the length and breadth of the slit were provided. The finder was much out of adjustment with the optical axis of the telescope, and required great trouble to get it right. When fixed, the intervening time was occupied in experiments on illumination and manipulation, until on the evening of the 17th August it was found that with Saturn on the wires of the finder, its spectrum was seen in the telescope. Major Tennant was indebted to M. Janssen, who was also near Guntoor, for the loan of a skilled workman and tools in making his final adjustments. Early on the 18th, preparations for observing the eclipse were commenced. The lines of the solar spectrum were carefully measured on the scale. The first contact was seen, and a few transits of the cusps over the wires taken, but this was soon given up. The times of some spots being bisected were noted. As the totality approached the tent was closed in, and the lamps lighted, Mr. Wilson taking his seat to record the observations. The driving clock was found to be very troublesome, and the slightest attempt to correct it upset the adjustments of the spectroscope. Directly the moon covered the sun, the finder being directed to the upper limb, a faint continuous spectrum became visible. The slit being narrowed, no bright lines were seen on it. There may have been dark lines, but Major Tennant did not see them. A prominence was then visible, the finder set on it, and a glorious spectrum of incandescent gas showed itself in the telescope. There were three bright lines, one brilliant red, one orange, not so strong, and one in the green beyond the iron line E; another was seen, but not measured, near F, and a faint one was suspected further on in the blue. The scale readings were made, and the sky became hazy till the sun reappeared. Measures of the solar lines were again taken for identifying the bright lines observed. The red and yellow were evidently C and D. The green was the brightest of the three lines *b*, and the other near F was probably F. E was not seen. These are the observations, and it is useless to speculate upon them at present. As to the observer's personal sensations, he did no feel so cold as he expected, and for which he had provided a great-coat, but the freshness of early morning seemed to last longer than usual. The view of the country around being shut out, he was unable to describe the effect of the eclipse upon it. Division 4.—The polarisation observations were made by Captain Branfill, who was kindly allowed by Colonel Walker to undertake the duty. The telescope was lent by Mr. Airy, being of 3¾ inches aperture, and 5 feet focal length. The object glass was one of the old collimators of the Greenwich transit circle. It had a portable stand, and an eye-piece and polarisers made by Mr. Ladd, the power being 30. The apparatus for these experiments were Nichols' single and double image prisms, a quartz plate, and Savart's polariscope. By combining these, four different tests of polarisation could be obtained, a hole in a diaphragm in the eye-piece showing, if the light of the Corona were polarised, when viewed by a Nichols' prism, darkness and light at alternate quadrants of a revolution, and with a double image prism and quartz plate circles of complementary colours. With Savart's plate, bands of light and darkness, or complementary colours, were produced in the same way. Captain Branfill had a tent to cover his instrument, and in the early part of the month tried experiments and accustomed himself to use the apparatus. During the progress of the eclipse he noticed the jagged edge of the moon, but could not see the entire limb before totality. Baily's beads were noticed, and a chain of red prominences was visible before the complete covering of the sun, and the large horn-shaped one immediately after. The prisms and plates, applied in various ways as tests, now distinctly proved that the light of the Corona was polarised in a plane passing through the sun's centre, and that of the red flames was not. All the combinations used gave the same result. The colour of the great horn was a beautiful rose pink, with silver threads. A detached cloud was rather higher, and two mountainous projections remained visible ten seconds after the sun reappeared. The cusps were blunted, which has been observed in former eclipses, but Captain Branfill did not know this. The sky was grey, with a yellowish tinge like a coming storm, and after the first momentary excitement the observer was calm and able to observe without feeling flurried. Division 5.—This section was explained by Mr. De la Rue, who said that Sergeant Phillips exposed six plates during the totality, as directed by Major Tennant, the telescope being a 9-inch silvered glass reflector made by Mr. Browning. At first Major Tennant was disappointed with the results, the negatives being faint, but upon printing it was found they afforded much information. Mr. De la Rue had received paper copies, which were exhibited to the meeting. They were faint, and sometimes the moon's entire limb was not seen, but they were full of detail, and upon the whole, he considered, highly satisfactory. The photographs were taken under unfavourable atmospheric conditions, but for measuring the heights of prominences and other elements would be far better than eye observations. This would be done when the large transparent positives arrived, but meantime some points had been made out. The position of the great horn and other prominences on each picture and the manner in which they were displayed or covered by the moon's advance were explained in detail. Major Tennant notices a very peculiar spiral structure in the great horn, as if two convolutions started from the base and met at the top. He suspected a change and spiral movement during the eclipse. There is also a great glare in a part of photograph No. 1, which might be due to exposure at the earliest moment of totality, or to something exterior to the sun. Division 6.—Major Tennant sums up his results as being; that the Corona is not self-luminous, but shines by reflected light; this being proved by both polariscope and spectroscope. There is one reservation as to this, that the flare in No. 1 shows an inherent luminosity in that part of the Corona, unless it be due to a modified form of prominence. The great horn is shown to be incandescent gas or vapour, and probably the other protuberances are of the same character. Hydrogen, sodium, and magnesium were present, and, issuing from the sun, ascended through the atmosphere, the lightest body, hydrogen, being carried farthest. Two powerful jets of vapour formed this horn which met at 16,000 miles high, and produced a vorticose motion. There is a similar appearance to be traced in Mr. De la Rue's pictures of the eclipse of 1860. Other currents of heated vapour might make the flare observed in one picture. If a continuous luminous stratum of no great extent, say 7,000 miles high, were produced in this way, it is suggested its breaking up might produce Baily's beads at the junction of the cusps. In concluding his narrative, Major Tennant observed that he had suffered much anxiety from the delay in the arrival of the instruments, and their condition when received, leaving scarcely a fortnight available before the eclipse; that the weather was against him, only about one-half of the totality being visible, but that notwithstanding he trusted he had added to our knowledge of the subject.

The President said the thanks of the Society were eminently due to Major Tennant for the admirable manner in which, under such difficult circumstances, he had performed the duty entrusted to him. The Society was also happy to see Sergeant Phillips, the actual photographic operator, present, and heartily thanked him for his share in the work.

On the Photographic Results of the Eclipse: by Mr. De la Rue.

The author said that, when the glass enlargements arrived, he intended to etch them, as he had done in 1860, although Major Tennant thought they would be too thin and pale for this purpose. Working on the paper copies, he found the prominences distinctly seen, but the moon's limb was not always complete. In these cases, by finding the centre, this could be traced round with compasses. By lines showing the path of the moon's advance, and one at right angles, the position of the moon's centre could be obtained at different times, and the position of the prominences, with regard to the sun's centre, measured. Mr. Hind had calculated the nearest approach of the centres of the sun and moon to be $3''\cdot9$, and the photographs showed it to be $3''$. The semi-diameter of the moon, as measured and calculated, also agreed within $4''$. The heights of the principal prominences were also given.* These results were only first approximations, and might be slightly altered on the measurement of the large glass positives, which would be nine inches in diameter. Major Tennant had pointed out the curious spiral structure of the great horn, which was also to be found in one of the Spanish photographs. A change in the appearance of the prominences during 5½ minutes is very likely, and, from Vogel's account, seems to have been noticed. A puzzling hole exists in one of the photographs. There is every reason to believe that the horn was in rapid rotation; and, by a diagram showing its direction, and the curve of its point, as observed at Aden, on board the Rangoon, at Guntoor, in the Malay Peninsula, and at Borneo, it would seem that these different phases could be accounted for by a rapid rotation on its axis in an hour or forty minutes. The picture of the red flame at Aden is taken from the *Engineer*, and much depends upon the accuracy of this. Both Major Tennant's photographs and Mr. De la Rue's, taken in Spain, show the deep indentation of the concave side of the largest prominence. Probably its base was slightly elevated. In 1860 there was no ring between the flames and the limb; but in 1868 a luminous ring is evidenced by the great blur of light in No. 1. Major Tennant believes there is a stratum of heavy luminous vapour exterior to the bright solar disc; but in a letter of November 28 says that Janssen accounts for the flare by its being a portion of the sun's limb not quite eclipsed. Mr. De la Rue could not say, from the paper copies, how this might be, but thought it was not due to the sun's limb. The author quoted some other accounts of the eclipse, and observed that there was still something to be done at future eclipses—1871 for instance—especially as to the luminous ring. He also wished to ask Sergeant Phillips his opinion as to the blur on the photograph.

---

* These data will be found in another page.

Sergeant Phillips said he thought the flare was produced by a portion of the limb of the sun. He was waiting for the totality, and looking through the only aperture in the tent, when he was ordered by Mr. Graham, who was watching for the calculated time, to expose a plate. At that moment the sun had not completely disappeared; but he obeyed as quickly as possible. The glare of light was, he considered, the last gleam of the sun.*

The President remarked that we had already derived much information from the eclipse expeditions; and no doubt much more would yet be worked out.

Mr. J. N. Lockyer, using Mr. De la Rue's diagram, pointed out that, when the moon advanced so as first to fit the sun's edge, this would be the most favourable spot for seeing prominences to their full extent, as at right angles to this line, the moon being larger than the sun, only the tops of very fine prominences would be visible. Again, as the moon advanced, so that the bottom limbs just coincided another range would be entirely uncovered if there situate. The observations of 1860 exactly corroborated this. There was a gentleman present this evening (Professor Grant) who, about 1848-50, had, from the records of previous eclipses, deduced the conclusion that there was a stratum of something round the sun's edge; but astronomers neglected the suggestion. Now he (Mr. Lockyer) had shown the existence of just such a stratum. It was desirable at the next eclipse (and they seemed to be coming rather more frequently), not only to get photographs in the line of totality, but also north and south of that line. Photography will thus do at an eclipse what the spectroscope does every day. The speaker was sorry Major Tennant was not present, to hear how his exertions were appreciated, and how the meeting felt for his difficulties with the clock and finder. At the next eclipse Mr. Lockyer thought it would be better to dispense with the clock altogether, and have the sun's image projected on a screen, where an assistant could keep it steady, and any particular part on the slit of the spectroscope as required. With regard to the bodies which the spectroscopic observations show to be present in the prominences, it is important to remark that there is a discrepancy between Major Tennant's conclusions and the subsequent discoveries here. The eclipse report gives hydrogen, sodium, and magnesium as certainly seen. Major Tennant was not quite sure of the line F at first; but he is now more confident, as all the observations concur in showing hydrogen to be present. Sodium, however, is not present. The yellow line seen is not a prolongation of the double D of the solar spectrum, but a more refrangible line. Mr. Lockyer exhibited a large diagram of the solar spectrum, with the lines mapped by Kirchhoff, and others shown by Mr. Gassiott's large spectroscope at Kew, above which the bright lines found in the prominences were drawn; but although the spectrum contained a very great number of faint lines, no one coincides with the new line near D, which fell on an absolutely blank space in the ordinary spectrum. The existence of magnesium is another point open to question. Major Tennant saw a line in the green which he thought one of the *b* lines; but Mr. Lockyer, who can see, at one time, the bright lines of the prominences and the dark ones in the spectrum of the sun's limb, doubts whether this green line be not produced by some other body. He finds that there are some bright lines in the spectrum of the sun's light, and that, like all bright lines, these are variable. Secchi has observed these bright lines, as well as Mr. Lockyer.

---

* Mr. De la Rue has since the meeting added the following note to his paper:—"The position angle of the centre of the glare is 10°·5 to the south of the first internal contact, and the glare could not have been caused by the last traces of the sun; but a furrow in the moon's limb may have allowed the passage of a minute beam of the sun's light, and this would have been quite sufficient to have produced the glare, and I think this is a probable explanation of the appearance."

Note on a Paper by Mr. Huggins, "On a Possible Method of viewing the Red Flames without an Eclipse:" by Mr. Lockyer.

In the paper referred to, read at the November meeting, the following passage occurs:—"The observations of the eclipse of August last having shown the position in the spectrum of the bright lines of the red flames, Mr. Lockyer and Mr. Janssen succeeded independently, by a similar method, in viewing the spectra of these objects." Mr. Lockyer considers that the obvious meaning of these words is to imply that the result of his work was based on the Indian observations. In refutation of this, he referred to his researches of 1866, wherein he indicated his hope of solving the problem by the spectroscope, and mentioned that, having only received his instrument on the 16th October, he within three days afterwards, and directly he had adjusted it, made his discovery. He pointed out that the lines reported to have been seen in India by different observers included the whole of the principal lines, and therefore afforded no guide to one part of the spectrum more than another, and gave other reasons in support of his argument.

Mr. Browning remarked that he had always had the impression that Mr. Lockyer's was an entirely independent discovery. For the last two years Mr. Lockyer had been speaking to him on the subject; and but for the illness first of Mr. Cooke, then of Mr. Lockyer, and last of the speaker, the spectroscope ordered would have been ready much earlier; and then he felt that as soon as this happened Mr. Lockyer would get something. We all knew the solar prominences were the object of Mr. Lockyer's research, and that he wanted an instrument he could keep on the sun's edge, and be sure it was kept there, so that what other observers had done was no help to him.

Mr. Stone wished to call attention to one date—that of Major Tennant's report, October 24—as it was clear that at this time Major Tennant could have heard nothing of what had been done here so as to induce him to modify any statement.

Mr. Huggins said: I prefer not to take up the time of the Society with a reply to Mr. Lockyer's remarks for two reasons: first, that it is easy for each one to decide for himself as to the degree of accuracy with which the positions of the bright lines were determined by the observers of the eclipse, and whether or not they were sufficient to guide an observer in his search for the lines; second, the circumstance whether or not Mr. Lockyer chose to avail himself of the information furnished by the eclipse is one in which he was quite free to act as he pleased.

The President: These explanations bring us nearer and nearer the truth. One fact is clear, that the two discoverers acted entirely independently.

Mr. Brayley, by permission of the Society, withdrew for the present a paper "*On the Visibility of the Luminous Prominences in certain telescopic observations of the Sun when not eclipsed, and on their Nature as Structural Elements of the Sun;*" and instead of it read a paper "*On the Relation of the Luminous Prominences to the Faculæ.*"

The author referred to the solar researches of Messrs. De la Rue, B. Stewart, and Loewy, and the eclipse photographs of the former gentleman, as affording evidence that the faculæ extended beyond the sun's limb, and that the luminous prominences and the faculæ might be the upper and lower portions of the same thing. He also quoted his own papers in the "Companion to the Almanack" to show that he had suggested there was probably a discontinuous stratum above the photosphere comparable to masses of detached clouds. The stereoscopic photographs of Mr. De la Rue showed that the faculæ were suspended above the spots and luminous surface, while the spots indicated that torrents of gas were projected therefrom; and the height of the faculæ above might be a measure of this force.

Mr. Stone: Is not the existence of such a stratum round the sun a direct deduction from Kirchhoff's theory? It strikes me this theory is coming well out of the fire, and is leading us to the true constitution of the sun. He certainly had serious objections made to his notion that the spots were bodies above the photosphere, and not hollows; and it is said observations disprove this, but the interpretation of such observations is exceedingly doubtful. The apparent depression of a spot at the edge of the limb can be otherwise accounted for, and is not conclusive. On the theory referred to, there must be vapour round the sun.

Mr. De la Rue, with reference to Mr. Brayley's paper, pointed out that there were faculæ seen during the August eclipse—some near the great horn, as well as in other places. The photographs of faculæ over sun spots showed conclusively they were at different heights. He had taken means to measure the relative brilliancy of the prominences, and found it 700 to 1,000 times less than that of the sun.

Mr. Huggins wished to remark, with reference to Mr. Stone's observations, that in a paper sent by Mr. Johnston Stoney to the Royal Society about a year ago it was shown that, supposing different vapours to proceed from the sun, their position at the limits of the atmosphere would be governed by their density—the lightest ascending highest. Mr. Huggins also thought that we should probably presently be able to reverse all the dark lines of the solar spectrum.

Mr. Stone: I think that Kirchhoff's own observations are getting confirmed. At first difficulties arose, but now they are being proved correct.

Mr. De la Rue: In the laboratory it is found that if gases are mixed, they diffuse, and do not range themselves according to density.

Mr. Huggins: Mr. Stoney shows that this law does not hold at the extreme limit of the sun's atmosphere. Without detracting from Kirchhoff, justice requires that it should be stated Mr. Stoney first pointed this out.

Professor Grant said that the discussion of all the eclipses had led him to the idea that the exterior coating of the sun must be non-luminous. Sir W. Herschel's theory of a photosphere, and then one or more reflecting surfaces below to account for the phenomena of the spots, was difficult to reconcile with this. The outer envelope and prominences might be accounted for by the eruption of matter from under the photosphere, and expelled to great heights.

Mr. Lockyer: Kirchhoff's theory is based on the hypothesis that incandescent gases give out bright lines, but Dr. Frankland has shown that it is the density of the gas which governs the fact whether bright lines or a continuous spectrum be produced. I am now working in conjunction with Professor Frankland on this subject, and hope to obtain some valuable results.

Mr. Balfour Stewart said that Major Tennant had related what he saw and what he considered his observations proved, but we must not build too much on one observation. The faculæ were the bright parts of the sun's disc, and the prominences were more likely to be connected with them than with spots.

Mr. Brayley said he did not connect the Indian observations with his theory.

Mr. Howlett remarked that there was no definite proportion between the magnitude of faculæ and of spots in their immediate neighbourhood.

Mr. De la Rue: It comes to this, that the spots are the least frequent occurrences. The changes of the faculæ and prominences are much more numerous. The spots are very useful for many purposes, and afford evidence of the immense projectile force at work in the sun.

Captain Noble said that at the time of the eclipse in 1860 he occupied himself in mapping the faculæ, and found there was no correspondence between their position and that of the prominences.

The following papers were announced as received:—

On the Physical Constitution of the Sun: by Lieutenant Ashe.

The Transit of Mercury: by Mr. Todd.

Description of the Great Nebula around η Argus: by Sir J. Herschel.

The Meteors of December 11: by Mr. H. P. Finlayson.

Mr. Perigal, Mr. Dallmeyer, and Mr. Penrose having been appointed auditors of the Society's accounts, the meeting adjourned.

THE GREAT SOLAR ECLIPSE OF 1868.

DATA FROM GRAPHIC DISCUSSION OF THE GUNTOOR PHOTOGRAPHS.

We have been favoured by Mr. De la Rue with the following results of his examination of the photographs taken by Major Tennant's expedition:—

Orbital motion of the moon's centre during the totality referred to the sun . . .	284°·5 to 105°·2
Measured orbital motion during the totality reduced to seconds of arc	132″
Relative motion of the moon's centre in R.A. during the totality	W. to E. 128″
Relative motion of the moon's centre in Dec. during the totality	N. to S. 32″·4
Orbital angle (inclination to a parallel) . .	15°
Position angle of 1st internal contact . .	101°
” ” 2nd ” ” . .	294°
Nearest approach of centres	7″
Ratio of lunar semi-diameter to solar semi-diameter = 1	1·07188

Prominence	Position Angle referred to sun's centre			Height above Sun's limb		Height above Moon's limb	
A	76°	to	81°·5	3′	17″	3′	2″
B	123	to	127	1	0	0	54
C	139	to	148·5	1	32	1	19
D	262	to	263	0	24	0	13
E	283·9	to	287·5	0	59	0	54
F	295·5	to	298·5	0	54	0	44
G	314·5	to	322	1	15	1	0
H	326	to	331	0	45	0	32
I	335	to	337·5	0	48	0	27

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

THEORY OF COMETS.

Sir,—Not seeing, in the November number, any allusion to Mr. Elvin's communication on the above subject, I feel inclined to make some reply.

And to begin with the postscript, with which I am very pleased, it should be a matter of high congratulation to the chief promoters of the *Register* that it does stir up the unknown amateurs in all parts, so as to do more real work for astronomy and science than any amount of mere bookwriting. I was with one of our leading men a short time ago, and alluding to the *Register* in favourable terms, he in reply took up a wretchedly printed little square German thing (whose name I dare not attempt to spell from memory), and said, "There; that is all you want: you need no more than just these figures, and you have all the recent data to calculate from." I then gently pleaded the cause of the *Register* on the above grounds, and I believe not ineffectually. Every crow that feels a little whiter than his fellow crow is so apt to take full credit for it.

Now for the comet. I think it will be found that with the mere motion of the sun it cannot form an orbit, but that it would move in a curve towards the sun *from any distance*, and, gradually coming up behind, would at last fall upon it, that is, if there is no motion in the comet. But if the comet has the smallest motion across the line of junction with the sun, it will be preserved from falling into it. And if this motion has been in the comet from all distances where the sun could influence it at all, it would trace a parabolic orbit; and if it has along with this motion in longitude a certain amount of its own towards the sun, it will form some hyperbole.

It seems to me that, to produce an ellipse at all, the comet must be *started* at a given place, and within certain limits as to direction and force; while, if a parabole or hyperbole is observed, it is proof that as long as the sun has been able to influence it at all, it has had a motion of its own, not only at right angles to the line of junction with the sun, but more or less towards it; and if this motion of its own towards the sun be next to *nil*, it will trace a curve nearest to a parabole on the hyperbolic side; a parabole being produced when there is no native motion towards the sun, but an eternal motion at right angles to it.

With regard to starting it, if it be started with a motion in longitude nearest to *nil*, while its motion to the sun is made anything less than it should be for a parabole at that place and direction, it will form the longest possible ellipse; while if it be started with a motion in longitude anything greater than it should be for a parabole in that place and direction, while its motion to the sun is the same or more than for a parabole in that place and direction, it will produce some hyperbole. If it is started with a motion to the sun, anywhere between *nil* and the amount for a parabole in that place, while its motion in longitude is anywhere between *nil* and the amount for the perhelion passage of a parabole at that place, it will produce an ellipse; that is to say, no ellipse can be produced by a wandering mass of matter which the sun may meet in space, it may be a parabole or the nearest possible hyperbole to it, or it may be a hyperbole of very great flatness; but the fact that it has been in motion from all distances, where the sun can have the least effect on it, precludes the chance of producing an elliptical orbit.

But a reservation should be made here; it is in favour of the theory. Thus as the maximum speed of a body forming a parabolic orbit is all borrowed from the sun, and as it will be all required to take it clear away from the sun again, it is evident that the least retardation of its velocity will prevent it from being able to get clear of the sun, and then it will form an elliptic orbit; so, too, as this orbit is produced by retarding the parabolic orbit, it will be diminished by the same means until it becomes a comparatively short ellipse.

This part I consider very feasible, as it is certain that the belts of aërolites will act on a vaporous body just as a vapour would act on a solid body.

But as for the nature of the comet, we are, I believe, very far from a clear knowledge of it, and I do not see how Mr. Elvin's ideas improve this.

First, the mass of matter called a comet *cannot be homogeneous* as he thinks, for with respect to its tail overreaching the head and passing on in opposition to the sun, it is simply impossible, all bodies or parts of bodies moving in a larger orbit than others *must* (notwithstanding all minor forces exerted *inter se*) lag behind those nearer to the sun. Then the head is necessarily *different in sort* from the tail, for it follows the laws of gravity in the form of its orbit, while the tail is demonstrably disobedient to these laws, and repulsive to the sun. It is also plainly seen to come from the head in streams, generally on the sunny side of the comet, and after passing through two or three stages of density, more or less distinctly marked, to rush off in a direction opposite to the sun. Thus, the head is plainly heavy, and has the power to retain a very large attenuated atmosphere around itself, but this atmosphere is clearly obedient also to the laws of heat and atmospheric electricity; this obedience need be no more powerful than it is on our own earth; and yet, by the indefinite lightness of the comet, as compared with the earth, may carry the atmosphere to a much greater distance. The power which keeps our own clouds from the ground is necessarily electrical, and this may act on the comet's atmosphere in the same way, simply sustaining it at an elevation proportioned to the amount of excitement which the comet suffers by the solar heat. This introduces the question, what develops the heat on the earth's surface? It may be developed more or less on any planet, but the mode of its development is to me quite a mystery; for how is it that it acts more in low parts and confined flat countries than in elevated ones and mountains? And why is it so cold on the mountain tops always? Their slopes are quite as capable of absorbing the heat as the valleys, but the air is so cold (of whatever sort the mountains may be) that it produces a snow line at the same height in the same latitude on all parts of the earth. Again, why and how do the clouds prevent the radiation of heat *from* the earth? I don't see why the heat should not still radiate as fast and get off as far as it can, but to say that the clouds prevent it in the manner of a blanket thrown over, is to make it apparently necessary that to place a screen in front of a light would prevent its shining. These are points which must be answered both clearly and carefully. I do not like to see explanations which would do as well for an opposite result, and yet I have seen such, and much worse even than this, come from very celebrated pens. To return to the question: though all these points are in themselves unexplained, yet they are observed as common facts, and thus may be very well taken as causes. We can well assign the law of gravitation to the production of particular results, without knowing what gravity is made of; and so, if the calorific and electric phenomena will help us here, by all means keep by them until something better is found. If, for instance, with the same faculties for developing heat, and with the same free electricity as we have, the nucleus of a comet was only 50 miles across, with one mean specific gravity, it would have but $\frac{1}{4000000}$ of our attraction over the elements of its atmosphere, which would allow any amount of expansion to take place.

I have often wondered on this point, whether there is anything but watery vapour in comets at all (except the nucleus); I cannot help thinking that, with the faculty for developing solar heat, and with the free electricity which we have, it would behave exactly as comets are observed to do.

The direction of the zodiacal light is not fixed, it moves to the left about 3° in 100 years; it is, however, at present about 30° from being opposite to the point where the sun moves to; and this motion of the zodiacal light is in the same direction as that of the curvature of the supposed solar orbit. In this I recognise the identity of the zodiacal light and the belt of aërolites; also Alcyone the centre of the solar orbit, which I warrant it is not.

A. DAWSON.

JUPITER'S SATELLITES.

Sir,—I was observing the eclipse of the 1st Satellite on October 2, but did not pay attention to the configuration of the others. However, the *Nautical Almanac* itself affords data for testing Mr. Gould's observation of the misplacement of the 3rd Satellite in the configuration table. If a diagram of Jupiter and the orbits of his moons be made to scale, and a line drawn parallel to the top of the paper, on which line the planet and satellites are marked as they appear to us projected, perpendiculars let fall from the latter on their respective orbits will give their places on their orbits for the given time; after which, knowing their respective daily angular movements, they may be traced in their progress round the planet (in the direction of the hands of a watch), and so be again projected on the straight line to show their configurations at any subsequent time required.

Making, therefore, such a diagram, and marking on the orbit of the 3rd Satellite its place on September 27, at its greatest W. elongation (assuming that to be correctly given in the *Nautical Almanac*), at the same hour on the 28th it will have gone over about 51°, and appear on the line of projection considerably nearer the planet. On the 29th, having moved 51° more, it would appear a little to the east, and previously to this it must have passed through Jupiter's shadow. Accordingly, on p. 465 this eclipse is given, the emersion, however, being invisible, since its place was behind the disc of the planet, the reappearance being from an *occultation*, which is also given in the table. On September 30 (51° more in advance) the 3rd Satellite was still receding from Jupiter, and approaching its greatest E. elongation, which on October 1 was past, and 3 had again begun to approach Jupiter. The configuration in the table for October 1 being only 22 hours later than for September 30, 3 moved about 47° in that time. So far all seems consistent in the *Nautical Almanac*; but on October 2 another arc of movement of 51° would bring 3 very near Jupiter (still, however, on the east), and close to the right of 1 in the table. This, therefore, accords with Mr. Gould's observations. Roughly estimated, 3 would not pass over the disc of Jupiter in about eight hours, and accordingly this phenomenon is given, p. 466. Another 51° brings 3, on October 3, to a point about half-way between Jupiter and its own greatest W. elongation, which it reached on October 4, as correctly laid down in the *Nautical Almanac*, having completed a whole revolution since September 27; the errors or misprints being in the configuration table for October 2 and October 3. The former, as noticed by Mr. Gould; the latter placing 3 too much to the west by about half. We cannot but wonder, considering the laborious computations required to produce such a magnificent work as the *Nautical Almanac*, and the enormous mass of figures it comprises, that errors and errata are so very rare.

Since the earth's orbit subtends an angle of 22° at Jupiter, an angle of 11° laid off at Jupiter on both sides of the visual line from the earth will mark the limits within which the shadow of Jupiter seen from the earth must always fall. At quadratures it will lie along one or other of these lines; at opposition, of course, along the visual line itself. The edges of the shadow may be considered parallel in a diagram of about the scale used in the *Nautical Almanac*, since they would not meet until prolonged more than 5 feet, Jupiter casting a shadow of the great length of nearly 53 millions of miles.

Teignmouth: Nov. 5, 1868. GEORGE J. WALKER.

Sir,—Your correspondents, Mr. Gould, R. P. D., and T. W. B., have evidently not seen the list of errata in the last published *Nautical Almanac* for 1872, where all their difficuties are accounted for. At page XV. of the *Almanac* for 1872 occurs the following to the *Almanac* for 1868:—"Page 480. Oct. 1, 2, and 3. The third satellite is misplaced; the arrangement should be as under."

You cannot be expected to reproduce the diagram here, but, referring to the configurations for October 1868, on October 2 the third satellite should be about as far to the *east* of the first satellite as the first is *east* of Jupiter. On Oct. 1 and 3, your correspondent, R. P. D., accurately describes the correction in the *Almanac* for 1872, when he says, "It (the third satellite) is placed manifestly too much to the west on Oct. 3, and not sufficiently to the east on Oct. 1."

It may be useful to some of your readers, and may save trouble, if I here copy the errata for the *Almanac* of this year, contained in the volumes for 1870-'71-'72.

In the *Almanac* for 1870 (*in some copies*), page 534, twelfth line from the bottom, "*for* 6h. 8m. *read* 12h. 15m."

In the *Almanac* for 1871 (*in some copies*), page 448, Oct. 14, μ Capricorni, col. "Diff. of apparent Dec. of moon and star," "*for* N. 62 15 *read* S. 62 15."

In the *Almanac* for 1872 (*in some copies*), page xii., third line from the top, "*for* Dominical Letters *read* Dominical Letter."

Page 279, *Apparent* Right Ascension, Jan. 30, "*for* 0 36 52·72 *read* 0 39 52·72."

Page 453, Nov. 21, "*for* ψ^1 Orionis, *read* χ^1 Orionis."

I am, Sir, yours obediently,
Edgbaston, Birmingham: GEORGE HUNT.
January 13, 1869.

Sir,—In answer to Mr. Denning (Jan., p. 17), I fear I have little of interest to communicate. Bad weather has been the almost invariable rule here for several months. Although I have diligently watched for a transit of III. this autumn I have not once succeeded. I have two or three notes of I. and II., which I append.

Sep. 24.—Not clear or steady. Tr. I.—The satellite seen from its ingress to nearly the middle of its transit, through haze; not very easily with 132. It was projected on the upper side of the S. dark belt.

Oct. 8.—Hazy at first. Tr. II. and its Sh.—Only caught by momentary glimpses between clouds; the images much boiling with 212; the Sh. very black and distinct. II. was seen as a white spot at various times to the middle of its transit. Both satellite and shadow traversed the faint, dark streak above the great S. belt.

Oct. 17.—Hazy and unsteady. Tr. Sh. III.—This was about half-way from the S. dark belt to the upper limb of Jupiter. The size of the intensely black spot was about equal to I. outside, but near, the disc; and certainly much less than III., which was also outside, but near, Jupiter. I could not resist the impression that this shadow, when most carefully focused with 212, had a very narrow ring of lighter tint surrounding it.

On the same evening.—Tr. I. and its Sh.—Both projected on the middle of the S. dark belt. I. was bright and pretty easy to mid-transit with 212. In steadier moments I thought I saw traces of a penumbra bordering the black umbra.

I am, Sir, yours truly,
Earith, Hunts: Jan. 14, 1869. T. H. BUFFHAM.

THE JANUARY METEORS OF 1869.

Sir,—I watched closely for the January meteors without success. My observation of the shower of January 2, 1867, was described by Mr. Lynn in the April number of the *Register* of that year, and he alluded to a similar display seen by Professor A. W. Herschel on the night of January 1, 1865. The great interest attached to these January meteors was pointed out by Mr. Lynn, who noted the proximity of the earth on Jan. 2 and Jan. 3 to the orbits of Comet II., 1782, and Comet IV., 1860. As the first nights of the present month, unlike Jan. 1868, were generally clear, I concluded that the shower must have taken place this year in view of some other locality. However, I have been lately informed by a person, on whom I could depend, that setting out on a journey on the early morning of *December* 31, he saw "one of the finest showers of falling stars" he ever witnessed. He also said, in answer to my enquiries, that they seemed "to fall in all directions from one part of the sky," which, if he pointed it out correctly, corresponded with the position of Cassiopea or Perseus at the time; but I had no great confidence in the accuracy of this part of his observation. If correct, it showed a radiant very far from that which I found for the meteors of Jan. 2, 1867, near the head of Draco, as stated in Mr. Lynn's letter. If those three showers belonged to our meteoric zone, it will be remarked that they were a day later in 1867 than in 1865, and a day earlier in 1868–9.

Millbrook, Tuam: Jan. 6, 1868. J. BIRMINGHAM.

THE TRANSIT OF MERCURY.

Sir,—As I observed the transit of Mercury on the 5th November last with a refractor by projection, I send you the following notes of my observation:—The instrument used was an achromatic, by Dollond, of 3⅞-in. aperture, powers 120 and 192, and the sun's image was projected on a screen in a darkened room to a scale of one minute to an inch.

The morning was not very favourable, heavy clouds obscuring the sun from time to time, but with intervals of pretty good definition between.

I noted that the planet was a little darker than the umbræ of the solar spots, and of one uniform tint. I saw no spot of light on its disc, nor did I observe any annulus around it; heavy clouds prevented my observing the egress.

I notice that two observers, using achromatics, state that the penumbra of the principal spot on the sun's disc was pierced by four umbræ. On referring to my drawings of the solar spots on that morning, I find there were five umbræ, but two were so close together, that by direct vision with small apertures, I have no doubt the division between them might easily have been overlooked.

Yours truly,
H. MICHELL WHITLEY.

Penarth, Truro:
Jan. 6, 1869.

LUNAR CHEMISTRY.

Sir,—It is commonly received as a fact that there is upon the moon's surface neither air nor water; or, what amounts to the same thing, *no gases.* If this be true, that there is no oxygen, it follows, as a matter of course, that there are no oxides, no earths, no rocks. What remains, therefore, of the moon's surface must be *pure metal.* The weight of the moon does not affect the question of composition, as all the metals are resplendent, whether heavy, as platinum, or light, as the kaligens, which float on water. It is stated that meteoric stones are never oxidised throughout their substance, but are merely burned on the surface by their rush through our atmosphere. We may assume, therefore, that there is no *weathering* in the meteoric zone; and all observation tends to prove a similar state of things on the moon. Supposing the theory to be correct, that the moon's surface is a corrugated metallic speculum, the bright face must ever maintain its radiance. There can be no lunar meteorology, and, as a sequence, there can be no attrition, no denudation, no rusting of the exposed metals; whilst, from the low icy temperature, sulphur can give no tarnish. No atmosphere means no storm, no stream, no cellular life, no decay. So long, therefore, as the moon fulfils her office, throwing upon this lower world the cold, steely glitter of her cubic crystals, she knows no change (unless electrical) save the ever flitting shadows of her mysterious mountains.

THOMAS WALTON, M.R.C.S. &c.

Hull: 21st Dec. 1869.

POWERS OF VISION.

Sir,—In the course of the last twelve months, I have observed that more than one of your correspondents have announced that they have seen the satellites of Jupiter with their naked eyes.

Without in the slightest degree impugning the veracity or good faith of your correspondents, I think it not only possible, but very probable, that they have been deceived. Our powers of vision differ only within certain limits, and although, as a mere matter of fact, it does not much signify whether the satellites have been seen or not, yet, in a physiological point of view, it were desirable that the fact could be tested. When the planet is in opposition, armed with a good opera glass of 2 inches aperture and magnifying five times, it is all I can do to bring the brightest of the satellites into view. With the same glass, I am able, with difficulty, to make out a few of the figures in the tables of the *Nautical Almanac*, at the distance of sixteen feet.

If any of your correspondents can do the same with their naked eyes there would then be no longer any reason to doubt that the satellites had been seen. The one feat would be as easy, or as difficult, as the other.

Clapham: 27th Dec. 1868. C.

THE TORONTO ASTRONOMICAL CLUB.—The first meeting of this Society took place on the first Tuesday in December last, at the Mechanics' Institute, Toronto, Canada. The following officers were elected for the ensuing year:—President, Mr. D. K. Winder; Secretary, Treasurer, Mr. S. Clare. The Society will meet on the first Tuesday in each month. We cordially wish this Society every success, in which we are sure our readers will join us.

ASTRONOMICAL PHOTOGRAPHY.—We trust that all amateur astronomers who are acquainted with and in the habit of using the photographic processes will endeavour to arrange more opportunities for taking sun views of any phenomena that may present themselves in the course of their observations. On the occasion of the last transit of Mercury a good photographic plate of the occurrence would have been very valuable; views taken at intervals, giving the path of the planet on the Sun's disk, would have proved an exact and unimpeachable record of the event. One of our correspondents sent us a photograph of the sun taken during the transit, but owing to imperfect appliances and want of preparation, the result was of little value, the planet being, in fact, so nearly imperceptible as to make the picture useless. Now, it is this want of preparation which is to be condemned, and we hope that those who are both astronomers and photographers will in future give some little attention to the appliances they possess, so that, on the occurrence of any phenomena of importance, such photographic views as may be practicable will be obtained, not by one or two, but by numerous observers, so that the results may be confirmed by independent means. We have not yet heard that any photograph of the transit of Mercury has been taken, although we feel sure that many skilful observers possessed the means for the purpose: the transit of Venus is yet distant, still it is not too soon to prepare. If only photographic means had been at hand on those occasions when the dark bodies were seen in the sun, which have given rise to the supposition of the planet Vulcan, this supposition might now have been a certainty instead of an astronomical enigma.

TARNISHING OF REFLECTORS.—In the January number of the *Register*, there is a letter from Mr. Grover, in which he refers to the tarnishing of reflectors. My own experience is as follows:—While in Blackheath, I silvered several mirrors, which retained their lustre untarnished, though almost without any protection whatever during a period of more than twelve months. Here in Manchester I keep them shut up in the wooden telescope tube, and I find that in about three months they are absolutely useless, being in parts of a deep blue similar to a watch spring, and over the rest of the surface exhibiting various shades of yellow and brown. I came here in April last with freshly deposited films, and since then I have been obliged to resilver the mirrors three times. A. W. BLACKLOCK.

ANOTHER BRILLIANT METEOR was observed by its reflected light shortly after one o'clock in the morning, in the neighbourhood of Brighton, on the 13th of January. Some accounts tell of an explosion heard at the time; others state that no noise took place. The light, which is described as of an indigo blue colour, illuminated the country round. No scientific result, however, is attainable from the accounts we have seen, as there are neither positions nor times given, without which no approximate idea of the path of the meteor (if it were one) can be arrived at.

THE TRANSITS OF VENUS.— I have read with great interest your report of the proceedings of the Royal Astronomical Society at their last meeting having reference to the coming transits of Venus. It would appear as though some difficulty was anticipated in interpreting the record which each observer may make of what he sees. Now it has occured to me that this may be obviated if, with the "maps of the transits" drawn out by the Astronomer-Royal, a series of views of what may be seen at ingress and egress at the different stations was prepared and published with those maps, with a special recommendation as to what each observer should note, he being requested to report that he saw No. 1 at such a time, No. 2 at such a time, and so on; all difficulty of comparing records would be at least diminished if not entirely got rid of. Mr. Stone's diagrams of the transit of Mercury published in the monthly notice for November, will illustrate my meaning, if indeed the idea has not already presented itself to his own mind. J.

COMES to ALDEBARAN.—In reply to J. R., allow me to state that I had long since discovered my error, and that the angle is correctly given by Webb. I saw the comes *while using a diagonal eye tube*, and I thoughtlessly forgot that I was using such an eye tube. By reducing my 3⅛ to 2⅞ in. aperture I can clearly see the comes. W. J. H. R.

ECLIPSES OF JUPITER'S FIRST SATELLITE,

COMPARED WITH THE NAUTICAL ALMANAC.

Observed by Mr. G. J. Walker, Teignmouth: Telescope, 3¾ in. aperture, power 175.

GREENWICH MEAN TIME.

1868	Aug. 31	Immersion,	12	36	20·8	Brightness decreased some time before disappearance.
		N.A.	——		28·4	
	Sept. 28	Immersion,	12	49	3·9	Haze: disappearance being close to planet, observation indifferent.
		N.A.	——		29·3	
	Oct. 18	Emersion,	9	43	27·4	
		N.A.	——		25·7	
	Nov. 10	Emersion,	9	59	9·9	First appearance very faint.
		N.A.	——		12·0	
	Nov. 26	Emersion.	8	19	32·9	First appearance very faint.
		N.A.	——		45·6	
	Dec. 12	Emersion,	6	40	39·4	
		N.A.	——		39·7	

Times probably reliable in general to one second.

LIST OF SUBSCRIBERS—Names received since our last number.

Cepeda, Sr. A. Rodriquez de, Valencia, Spain.
Guyon, G. Esq., South Cliff Cottage, Ventnor, Isle of Wight.
Hollis, H. W. Esq., The Cottage, Osmaston Manor, Derby.
Knothe, Albert, Esq., Northumberland Terrace, Teignmouth, North Shields.
Lamb, W., Esq., 1 Clifton Terrace, Ranelagh Road, Dublin.
Tuson, Miss, Northover House, Ilchester, Somerset.
Vines, D., Esq., 35 Somerset Street, Kingsdown, Bristol.
Walton, T., Esq., 3 Bourne Street, Hull.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To December 1868.
Broughton, S.
Landell, W. W.
Thrustans, J.

To March 1869.
Cotsworth, H.
Denning, W. F.
Elliott, R.
Evans, W.
Guyon, G.
Jackson, Mrs.

To April 1869.
Blacklock, A.

To June 1869.
Alsager, J.
Andrews, W.
Briggs, Miss
Court, J.
Freeman, D. A.
Hubbersty, Rev. R.
Jenkinson, Rev. J. H.
Rump, R.
Slater, James
Walton, T.

To December 1869.
Backhouse, T. W.
Bird, F.
Cepeda, Sr. A.
Clark, J. S.
Compton, A. S.
Cundell, G. S.
Daw, E.
Dobie, Dr.
Green, N.
Hill, C.
Hollis, H. W.
Hunt, G.
Knothe, A.
Radford, Dr.
Ratcliffe, J.
Redpath, H. S.
Simkiss, J.
Smyth, C. P.
Stanistreet, J. F.
Tuson, Miss.
Vallack, Rev. B.
Weldon, Mrs.
Wilson, T.
Wolley, Rev. R.

January 21, 1869. Subscriptions after this date in our next.

NOTICE TO CORRESPONDENTS.

ERRATA. In No. 73, p. 3. In list of Fellows elected, for W. Vines, read David Vines; p. 24, line 10 from bottom, for *described* read *deserved*.

We are compelled to defer many communications for want of space.

ASTRONOMICAL OCCURRENCES FOR FEB. 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Mars —
Mon	1	 11 35 12 34	Sidereal Time at Mean Noon, 20 46 55·2 Occultation of 80 Virginis (6) Reappearance of ditto			13 23·9
Tues	2		Meridian passage of the Sun, 14m. 1s. after Mean Noon	1st Tr. I. „ Sh. I.	8 29 9 38	13 18·7
Wed	3	4 56 12 22	☾ Moon's Last Quarter Greatest easterly elongation of Mercury, 18° 15′	1st Oc. D. „ Ec. R.	5 50 9 9 26	13 13·4
Thur	4			1st Tr. E. „ Sh. E.	5 14 6 20	13 8·0
Fri	5	11 51	Conjunction of Moon and Saturn, 3° 5′ S.	3rd Oc. R. „ Ec. D.	6 10 7 59 16	13 2·7
Sat	6			2nd Tr. I. „ Sh. I. „ Tr. E.	5 57 8 12 8 30	12 57·3
Sun	7					12 51·9
Mon	8					12 46·4
Tues	9	1 48	Conjunction of Moon and Venus, 2° 0′ S.			12 41·0
Wed	10			1st Oc. D.	7 51	12 35·5
Thur	11	 1 54	Eclipse of the Sun, invisible at Greenwich ● New Moon	1st Sh. I. „ Tr. E. „ Sh. E.	6 2 7 15 8 16	12 30·1
Fri	12	2 16	Conjunction of Moon and Mercury, 4° 47′ N.	1st Ec. R. 3rd Oc. D.	5 33 49 7 37	12 24·6
Sat	13	1 12 4 39	Conjunction of Mars and η Leonis, (4 m.·2.) E. Opposition of Mars	2nd Tr. I.	8 45	12 19·1
Sun	14		Illuminated portion of disk of Mars, 1·000			12 13·6
Mon	15	5 34	Conjunction of Moon and Jupiter, 3° 30′ N.	2nd Ec. R.	7 19 46	12 8·1

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Moon
Tues	16		Sidereal Time at Mean Noon, 21 46 3·5			3 46·2
Wed	17		Meridian Passage of the Sun, 14m. 14s. after Mean Noon			4 29·8
Thur	18	12 24	Occultation, disappearance of *f* Tauri (4)	1st Tr. I. „ Sh. I. „ Tr. E.	7 1 7 58 9 16	5 15·4
Fri	19	0 57 5 6 9 16 9 49 11 14 12 3	Inferior conjunction of Mercury ☽ Moon's First Quarter Occultation of 48 Tauri (6) Reappearance of ditto Occultation of γ Tauri (4) Reappearance of ditto	1st Ec. R.	7 29 16	6 3·6
Sat	20		Saturn's ring: Major axis = 37″ Minor axis = 16½″			6 55·1
Sun	21	12 34 13 26	Occultation of 71 Orionis (5½) Reappearance of ditto			7 50·0
Mon	22	4	Conjunction of Moon and Uranus, 3° 19′ N.	2nd Oc. D.	5 45	8 47·8
Tues	23	10 18 11 21 16 25 17 15	Occultation of ζ Cancri (5½) Reappearance of ditto Occultation of d^2 Cancri (6) Reappearance of ditto	3rd Sh. I. „ Sh. E.	6 5 8 35	9 47·6
Wed	24	10 52 11 47 22 46	Occultation of π^2 Cancri (6) Reappearance of ditto Conjunction of Moon and Mars, 4° 7′ N.			10 47·8
Thur	25	6 38 7 37	Occultation of α Leonis (1½) Reappearance of ditto	1st Tr. I.	9 2	11 47·3
Fri	26	0 5 5 56 13 32 14 19	○ Full Moon Near approach of Moon to χ Leonis (5) Occultation of σ Leonis (4) Reappearance of ditto	1st Oc. D.	6 23	12 45·1
Sat	27	8 45 18 35	Near approach of Moon to 10 Virginis (6) Conjunction of Venus and Mercury, 3° 54′ N.	1st Tr. E. „ Sh. E.	5 47 6 35	13 41·0
Sun	28					14 35·3
Mon Mar	1			2nd Oc. D.	8 35	15 28·4

THE PLANETS FOR FEBRUARY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	22 25 46	− 8 50½	7″·2	1 22·8
	20th	21 58 42	8 26	10″·4	noon
Venus	5th	19 46 56	−21 23½	10″·8	22 40·5
	20th	21 4 38	17 34	10″·4	22 59·0
Mars	5th	10 7 30	+16 21½	16″·2	13 2·7
	20th	9 44 25	18 19	16″·2	11 40·7
Saturn	5th	16 56 53	−21 2½	14″·4	19 50·9
	20th	17 0 59	21 7½	14″·8	18 56·1
Uranus	5th	7 1 47	+23 8	4″·2	9 57·5
	20th	6 59 52	23 10½	—	8 56·5
Neptune	2nd	0 57 37	+ 4 25		3 54·7

Mars will be the most conspicuous planet this month, arriving at opposition on the 13th. A Table of Stars to be observed with the planet is given in the *Nautical Almanac* for 1869, pp. 491–7. This is for the purpose of determination of the solar parallax, and is useful only to those who possess powerful instruments. Repeated measures of the differences of declination between the stars and the planet may be taken on the same night with the equatorial, the times of the observation being noted.

URANUS AND NEPTUNE.—Uranus will be well fixed for observation during the month of February, passing the meridian about ten o'clock in the evening at the beginning of the month, and at about half-past eight at the end of February. The planet is near the third magnitude star δ Geminorum. *Neptune* may also be seen almost close to Jupiter in the evenings, in the western sky, but these planets are passing from view. On the 1st of the month the small planet will be a very little to the left of Jupiter and little more than a degree above him. On the 19th the two planets will have almost the same declinations; on the 27th they will have almost the same right ascension. On the 2nd of March Neptune will be a little to the right of Jupiter, and less than a degree below him.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 75. MARCH. 1869.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868-9.
Fourth Meeting, February 12, 1869.
The Annual General Meeting.
Admiral Manners, *President*, in the Chair.
Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Minutes of the last annual meeting were read and confirmed.

The report of the Council, including that of the auditors, was presented and extracts read. It contained the usual statistics as to the number of Fellows, the funds and property of the Society. The obituary included the names of Sir David Brewster, Major-General Shortrede, Messrs. Chabot, Cooke, Dawes, Westcar, Porrett, Jenkins, Barton, Worthington, and the King of Siam, an honorary Fellow. Biographical notices of the Rev. W. R. Dawes, Major-General Shortrede, and Mr. Jenkins were read. From the first we extract a few particulars.

Mr. Dawes was born March 19, 1799, at Christ's Hospital, where his father was mathematical master. Mr. Dawes, senior, being appointed Governor of Sierra Leone, Mr. Dawes was brought up at the Charterhouse, and afterwards under the care of the Rev. Thomas Scott, the commentator on the Bible. He was designed for the Church, but feeling scruples as to some of its tenets he studied medicine, and became a general practitioner at Haddenham, Berks. In 1826 he went to Liverpool, and soon after became a Dissenting minister at Ormskirk. Here he first turned his love for astronomy into practice, and erected an observatory, where, with a 5-foot refractor, he commenced those observations on double stars which have since rendered him so well known. Leaving the ministry in 1839, he took charge of Mr. Bishop's observatory in the Regent's Park. In 1844 he removed to Cranbrook, in Kent, and worked with a fine 6-inch telescope by Merz; and after an interval spent at Torquay through illness, he removed first to Wateringbury, near Maidstone, and ultimately, in 1857, to Haddenham, where he died February 15, 1868. He was twice married, and survived his second wife. During the latter years of his life he used successively telescopes by Alvan Clarke of 7½, 8, and 8¼-inches aperture, and an 8-inch one by Cooke. His beautifully accurate measures of double stars, his ingenious instrumental contrivances, his independent discovery of the dark ring of Saturn, and his work on the solar disk are all referred to in the notice of which this is an abstract.

The reports from the various observatories mention that at Greenwich, besides the usual extensive labours, a new seven-year catalogue of 2,760 stars from 1861 to 1867 is being formed.

The transit of Mercury over the sun's disk was very successfully observed. Independently of the value of the observed times of egress, the phenomenon gave the observers an opportunity of noticing the formation of the black ligament, and of deciding the question of the reality of the existence of the *two* phenomena of real and apparent internal contacts, as explained by Mr. Stone in his recent paper on the 'Re-discussion of the Observation of the Transit of Venus in 1769.'

At Cambridge the Sun, Jupiter, Uranus, Neptune, and Iris, with some fundamental stars, had employed the meridian instruments. Brorsen's and Winnecke's comets, and some occultations, had been observed with the Northumberland equatorial. A new meridian circle, by Simms, is in a forward state, and would, it was hoped, soon be mounted. At Oxford the transit circle and heliometer had been actively employed, and a second Radcliffe Catalogue was essentially complete. Much care had been bestowed upon meteorology, and a curious force, producing an increased velocity of the wind after 7 A.M., had been discovered by Mr. Baxendell upon discussing these observations.

The Royal Observatory, Edinburgh, continued to distribute time by a ball, a gun, and controlled clocks. Much meteorological work was also done and standard stars observed.

Glasgow also devotes much attention to time and meteorology. Some stars and planets are likewise observed. The work done at the observatories at Liverpool and Kew and those of Mr. Huggins and Lord Rosse was also referred to.

The next volume of *Memoirs* will contain Major Tennant's report on the Solar Eclipse of August 18, 1868. The paper will be accompanied by engravings of the photographs, enlarged under the superintendence of Mr. Warren De la Rue.

An index to all the papers contained in the publications of the Society, from its commencement down to the end of 1868, is nearly finished, and will shortly be forwarded to press.

Twelve minor planets have been discovered during the year 1868. This is the greatest number added to the list of planets in any single year. The date of each discovery is as follows :—

Planet.	Discoverer.	Date of Discovery.
Ægle	Coggia	1868, February 17
Clotho	Tempel	„ February 17
Ianthe	C. H. F. Peters	„ April 18
(99)	Borelly	„ May 29
Hecate	Watson	„ July 11
Helena	Watson	„ August 16
Miriam	C. H. F. Peters	„ August 22
(103)	Watson	„ September 7
(104)	Watson	„ September 13
(105)	Watson	„ September 16
(106)	Watson	„ October 10
Camilla	Pogson	„ November 17

A Comet was discovered by Dr. Winnecke on June 13.

Brorsen's and Encke's periodical comets have been observed at their respective appositions.

The spectrum of Comet II., 1868, has been examined by Mr. Huggins.

There appears a very close agreement between its spectrum and that of carbon, when vaporised in olefiant gas.

The Society is indebted to the Astronomer-Royal for an elaborate discussion of the best means for utilising the approaching transits of Venus in 1874 and 1882.

The method of differences of observed durations will not be available for the determination of solar parallax in 1874, and probably also not in that of 1882.

It will thus be necessary to determine with extreme accuracy the longitude of the different stations. This necessity calls for immediate action. The Astronomer-Royal has most carefully pointed out in his paper the stations which are best adapted for the location of the observers.

Mr. Warren De la Rue has urged the advisability of supplementing the eye-observations by photography. He is of opinion that a value of the solar parallax of considerable weight may be thus obtained. His great experience and proved skill in the deduction of accurate results from photographic registers entitle his opinion to the greatest consideration.

The Astronomer-Royal has proposed that altazimuths should be employed in the determination of the longitudes of the stations. Results of very much the same value as those to be expected from photography might probably be obtained without any additional expense, or interfering in the slightest degree with any other results, by simply observing throughout the transits, with those altazimuths, the position of the planet with reference to the sun's limbs.

The labours of Mr. Ellery upon the southern survey of the heavens, of Mr. Knott upon ζ Herculis, and of Mr. Huggins upon the motion of Sirius, which, from an alteration in the refrangibility of the hydrogen line F, he concludes is receding from the earth in the line of sight at the rate of 29·4 miles a second, were next referred to.* The November meteors continue to be seen in great numbers in some places, showing that the condensed portion of their track is more extensive than was supposed. Three fine pictures of the great nebula in Orion have been completed; one by Lord Rosse, one by Mr. Lassell, both of which are published by the Royal Society, and the third by Padre Secchi, which will be of the greatest value to future astronomers. Much information on this subject is to be expected when the great Melbourne reflector is applied to this object. With the spectroscope Lieut. J. Herschel has detected a fourth gaseous line in this nebula, which is confirmed by Lord Rosse and another observer. The work done at the Cape of Good Hope, and Mr. Stone's numerous papers having been mentioned, it was stated that the Society's Gold Medal had been awarded to that gentleman. A considerable space was then devoted to a narrative of Mr. Lockyer's discovery of the method of perceiving the presence and constituents of the red flames without an eclipse, and of the stratum round the sun called by him the chromosphere,† and of M. Janssen's independent researches on the same subject, and with the like result; and the remainder of the report was occupied, in consequence of the importance of the eclipse, by the accounts, in the observers' own words, of their labours, including Lieut. J. Herschel's account of his observations at Jamkandi, with the spectroscopic results; ‡ Lieut. Campbell's experiments on the polarisation; M. Rayet's observations at Wah Tonne, where he saw in the spectrum of the protuberance the lines B D E *b* F G and three others; and M. Janssen's long report of his mission and its results.

The President's Address.

Admiral Manners said it now became his pleasing duty to offer to Mr. Stone the usual recognition by the Society of useful work ably performed. It was nearly nine years since Mr. Stone had become first assistant at Greenwich, where he succeeded a gentleman who was universally respected; and coming from Newton's University, had proved himself eminently qualified for the post.

---

* Vide *Astronomical Register*, vol. vi. p. 155.

† *Ibid.* p. 263.

‡ *Ibid.* p. 233.

It was not, however, any amount of official work that the Society could notice, but the medal was awarded for a long series of important contributions, all the result of labour out of business hours. These papers on physical astronomy had all a tendency to improve our knowledge of the values of the fundamental constants of the science, and were, in a great measure, founded on the stores of valuable observations which were recorded at the Royal Observatory. The President would commence with Mr. Stone's Researches on the Solar Parallax. The ancient astronomers were quite ignorant of the value of this, supposing it was to be estimated by minutes instead of seconds; and it was not until the seventeenth century, when telescopes were applied to graduated instruments, that attempts were made, based on sound principles, to find out the desired quantity. To ascertain the change produced by observing the sun directly at different places, was beset with difficulties; but fortunately there were two planets—one, Venus, within the earth's orbit; and the other, Mars, outside it—by the aid of which the result might be obtained indirectly. Dominic Cassini succeeded in getting 9″ as an approximate value, which was a very good result. Many subsequent values, professing to be improvements, were only the reverse. Halley pointed out a new method of obtaining the solar parallax, founded on observations of the transit of Venus; and this led to the expeditions sent out by various Governments in 1761 and 1769. The observations of 1761 were imperfect, but in 1769 they were successful, and gave results of 8″·6 and 8″·8, but no complete discussions of the whole took place until Encke, in 1824, undertook the task and arrived at 8″·5776 as his result, which was universally accepted and acted upon until recently, when suspicions began to be entertained that this value was too small. In 1836 Henderson, from observations of Mars at the Cape of Good Hope, Greenwich, and Altona, deduced a value of 9·″028, but his materials were too scanty. In 1857 the Astronomer-Royal referred to this subject, and urged observations of Mars at the oppositions of 1860 and 1862. Hansen's labours on the Lunar Tables also led him to doubt the accuracy of Encke's value; and this suspicion was strengthened by Le Verrier's researches, who showed that the motions of Mars and Venus all implied a greater parallax of about 8″·95, which agreed closely with Hansen's result. Foucault's experiments on the velocity of light also showed the necessity of a decrease in the radius of the earth's orbit. The year 1860 passed over without result, but the opposition of Mars in 1862 was well observed, and Mr. Stone investigated the subject. The method used was to take the difference of meridian declinations of Mars and stars near to the planet; and by discussing the observations made at

Greenwich, the Cape of Good Hope, and Williamstown, Victoria, and embodying the result in nine tables, Mr. Stone obtained a value of 8″·943 for the solar parallax, with a probable error of 0″.051. This was a most satisfactory agreement with the result obtained from other sources. He next, in a paper on the coefficient of the Moon's parallactic inequality, obtained a result of 8″·850; Hansen's value being 8″·916. Better materials being now available than in Encke's time with respect to the longitudes of the stations, Mr. Stone has re-discussed the whole of the observations of the transit of 1769; and by using all the sets of complete observations, and by carefully distinguishing between apparent and real contacts, as shown by the observers' own words, he has found that those observations thus fairly interpreted give a parallax of 8″·91, with a probable error of 0″·03; thus bringing the whole series of methods into satisfactory accordance. This important investigation has earned the gratitude of all astronomers; it has shown the justness of Halley's method, and wiped away all reproach from the observers of 1769, some of whom had been unjustly suspected of tampering with their figures. He has shown how words differed in meaning to different persons; and his paper will be invaluable in preparing observers for the future transits, who will thus learn how to record the phenomena they may witness on a uniform system.

The President then referred to other papers by Mr. Stone, including one on the Lunar Parallax, in which the question of personal equation at the two limbs of the Moon was discussed; another on the accuracy of the places of the stars as shown by the 3 Greenwich Catalogues—1, the 12-year Catalogue; 2, the 6-year Catalogue 1850; and 3, the 7-year Catalogue 1860, in which he discusses two questions: first, are the results affected by fundamental errors? and second, is the process adopted in preparing these catalogues calculated to lead to progressive accuracy? An important paper on the Refraction Tables used at Greenwich, which are Bessel's with slight modifications, was also described, and the result of a comparison of the Greenwich observations with those at Melbourne pointed out. To Mr. Stone we owe a paper on the spurious disks of stars; two papers on the constant of Lunar Nutation, the value of which he finds to be 9″·139, which is slightly smaller than that of all other computers except Lindenau; and an independent determination of the Moon's mass, which he brings out $\frac{\text{Moon}}{\text{Earth}} = \frac{1}{81\cdot36}$. There are other labours of Mr. Stone yet to be added to the list; and the President said in conclusion, that in presenting the Gold Medal to Mr. Stone it was to be regarded not only as the highest testimonial the Society had in its power to bestow, but that every astronomer would recognise in it the strongest evidence of the consummate ability which distinguished Mr. Stone's labours in every branch of astronomy to which he had devoted any of his attention.

It was moved by Admiral Ommanney, seconded by Mr. Burr, and resolved—

That the Report of the Council be received, and with the President's address be printed and circulated in the usual manner.

W. J. H. Beechey, Esq.
J. R. Jones, Esq.
J. Lee, Esq.
G. W. R. Piggott, Esq.
and
T. Ryle, Esq.

were balloted for, and duly elected Fellows of the Society.

Mr. Browning and Mr. Burr having been nominated as scrutineers, the ballot for the election of officers took place, with the following result:—

President.

Admiral Manners.

Vice-Presidents.

J. C. Adams, Esq., M.A., F.R.S., *Lowndean Professor of Astronomy, Cambridge.*
A. Cayley, Esq., M.A., F.R.S., *Sadlerian Professor of Geometry, Cambridge.*
Warren De Da Rue, Esq., F.R.S.
Rev. Charles Pritchard, M.A., F.R.S.

Treasurer.

Samuel Charles Whitbread, Esq., F.R.S.

Secretaries.

William Huggins, Esq., F.R.S.
Edward J. Stone, Esq., M.A., F.R.S.

Foreign Secretary.

Lieut.-Col. Alexander Strange, F.R.S.

Council.

G. B. Airy, Esq., M.A., F.R.S., *Astronomer-Royal*
Rev. Prof. Challis, M.A., F.R.S.
James Henry Dallmeyer, Esq.
Edwin Dunkin, Esq.
Prof. T. Archer Hirst, Ph.D. F.R.S.
George Knott, Esq.
William Lassell, Esq., F.R.S.
J. Norman Lockyer, Esq.
Rev. Robert Main, M.A., F.R.S., *Radcliffe Observer*
Captain William Noble.
Balfour Stewart, Esq., M.A., LL.D., F.R.S.
Isaac Todhunter, Esq., M.A., F.R.S.

Upon the motion of Mr. Browning, seconded by Mr. Perigal, thanks were voted to the retiring Vice-Presidents and members of Council; and

The meeting adjourned.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

ASTRONOMICAL PHOTOGRAPHY.

Sir,—When it is considered how very simple a matter it is to obtain photographs of the Sun and Moon, it certainly is a matter of surprise that the possessors of telescopes do not oftener use them for the purposes of photography; and I am glad to see that you have again called attention to the subject.

It has often occurred to me that amateurs have been deterred by some of the accounts published of very elaborate instruments and apparatus; but I have more than once pointed out that with the simplest appliances extremely good results may be obtained. Failures arise more from atmospheric causes than from defective manipulation.

You refer to the "want of preparation" as the cause of a photograph of the late transit of Mercury being of very little use. By adopting the method suggested in my paper on "Celestial Photography" it is possible to be always prepared, and I have repeatedly proved this by producing four negatives of the Moon in less than ten minutes from the time of opening the observatory and adjusting the driving clock; with assistance the time occupied would be rather less. In order to be always prepared it is only necessary to keep some glass clean and ready for use, and to see that the collodion and developing solution are in good working order. This is more particularly necessary for the Moon.

I was unable to photograph the transit of Mercury, as the Sun was too low for the position of my observatory; but the state of the atmosphere at the time would have prevented any good result.

If any of your readers desire further information, I shall be very glad to answer any enquiries through the *Register* or by letter.

Yours obediently,
A. BROTHERS, F.R.A.S.

Wilmslow, near Manchester:
February 16, 1869.

THE PLANET MERCURY.

Sir,—No doubt many of your readers saw the planet Mercury during its last eastern elongation. It was quite a conspicuous object near the western horizon on the evening of the 5th instant, and was also distinctly visible to the unassisted eye on the 2nd, 4th, and 6th, soon after sunset.

It presented a very ill-defined appearance in the telescope, which was no doubt owing to the planet's proximity to the horizon.

In brilliancy I should suppose it equalled a star between the first and second magnitudes.

I am, Sir, truly yours,
WILLIAM F. DENNING.

Ashley Road, Bristol:
February 12, 1869.

THE SUN'S DISTANCE.

Sir,—In your December number I asked for information touching a point in your neat October exposition of the history and present state of the solar parallax problem—a problem which all the nations of the earth are beginning to ferment with, and will doubtless continue to wax warm upon until 1882; and in the present January number your correspondent "W. T. L." gives that requested information. I thank him, therefore, for it, though much regretting that he has so far misstated my question that I do not recognise or acknowledge it as put by him.

My question was, essentially, "why, in your account of a recent paper (supposed of date June 1868), did the author, *who had done everything else in it admirably, and was worthy there of the highest praise*—why did he omit to mention the *priority* of Professor Simon Newcomb?"

The answer now given by "W. T. L." not only applies to what Professor Simon Newcomb printed in 1867, but also to what M. Powalky printed, on the same old-transit-of-Venus problem, in 1864; for it furnishes as the reason and justification, "Because M. Powalky's method of research has not been thought very highly of, and Professor Simon Newcomb merely reprinted and published, with his own adoption and approval, Powalky's final result; while the other and more recent author has made an entire and admirable re-discussion of the whole problem, and *his* resulting quantity (greater by 0·05 of a second) is now preferred to Powalky's, even by Simon Newcomb himself."

If this answer is universally considered to settle the *priority* question in the direction indicated above, I have failed to appreciate the spirit of the age we live in; and remain,

Sir, your obedient servant,

P. S.

COMPARISON OF THE ACHROMATIC AND REFLECTING TELESCOPE.

Sir,—The last few numbers of the *Astronomical Register* having contained correspondence on this subject, in which occur many exaggerated and incorrect assertions, I forwarded a letter, in which I briefly reviewed some of the statements put forth. In justice to this question—one of great importance to every amateur, as well as professional astronomer—I beg to put forward a few additional notes on the subject. A paper on the performance of a 6½-inch silvered glass reflector, which I have successfully mounted, will be found in the *Register* for July 1867, and some further remarks on the same topic in the number for May 1868. At present this instrument is employed in a sidereal survey, as mentioned in the *Register* for August last, in the carrying out of which its illuminating and defining qualities will be pretty sure to be severely tried.

As to the achromatic telescope, my experience has been confined to five years' work with a 2-inch object-glass of 36-inch focus, with occasional access to larger apertures. The excellence of the 2-inch object-glass is fully proved by communications in the *Register* for March, July, August, and October 1865, September 1866, and November 1867; and the communications of other correspondents, using larger achromatics, afford abundant proof of the wonderful perfection which this instrument has attained in the hands of modern opticians.

It should be remembered that science will not be advanced by a hasty reference to the subject by persons obviously knowing but little of practical astronomy, and each biassed in favour of his particular instrument. The reflector and achromatic have both equal claims to consideration, according to the work in which they are employed. And while the achromatic is, and probably always will be, the most suitable for those purposes in which exact measurements are required, the reflector is entitled to quite as much consideration as the instrument best adapted to the wants of that numerous class of amateurs who delight in the beauties of the planets, or the wondrous forms of the nebulæ, and look upon the double stars not with the critical eye of the astrometer or professional astronomer, but as objects of beauty for contrast of colour, or of interest as tests for the defining and separating power of their mirrors.

In this latter particular they are quite equal to the finest achromatics of equal aperture. Any doubt on this point may be at once removed by reading an able article in the *Register* for June 1865, by the Rev. W. R. Dawes, "On the Separating Power of Telescopes;" or it may be proved by the results of observations on that well-known test object, γ^2 Andromedæ. At p. 171 of Dawes' valuable catalogue of double star measures, we read: "With Alvan Clark's 7½-inch object glass never quite divided, though there is a dark line across the deeply notched disc, the smaller star is flattened a little at the point of contact;" and at p. 453: "With Alvan Clark's 8¼-inch object glass, the stars cleanly divided, with scarcely any light about them." The Rev. T. W. Webb (*Intellectual Observer*, vol. ii. p. 374) says: "Cooke's beautiful object glasses, of little more than 4-inch aperture, will elongate it; and Mr. Lockyer, of Wimbledon, has divided it with a 6¼-inch by the same hand—a great triumph of optical skill." . . . I have repeatedly elongated it with my 5½-inch object glass.

In Mr. Browning's "Plea for Reflectors" it is stated that a 6½-inch silvered glass speculum has divided this object—a statement concerning which a correspondent of the *English Mechanic* is pleased to remark, "that it must have been done on a night of such extraordinary clearness as is not likely to again occur." Those who know Mr. Browning are well aware that his character for veracity stands above question; and from what I see in my own instrument I believe it to be quite possible. With a power of 300 it is always strongly elongated, and on fine nights deeply notched. I greatly regret that I have no higher power, as I am quite sure that a power of 450 or 500 would divide the little discs. Moreover, it must be borne in mind that though I have achieved unlooked-for success in the mounting of my mirror, it can scarcely be considered equal in exactness to the telescopes made by Mr. Browning, whose beautiful instruments I have never had the pleasure of inspecting.

As to light-grasping qualities, they are stated to equal an achromatic of ⅙ less aperture; and in practice I find this quite correct. Quite recently I applied a cardboard disc, with an opening of only 2½ inches in diameter, and examined some of the stars mentioned in the *Register* for November 1867, as observed and measured with the 2-inch achromatic, and with the appearance of which I was well acquainted. I was surprised to find that with this aperture they were not so well seen as with the achromatic, till I considered that the plane mirror was of course large beyond all due proportion for such a very small aperture; and I found, on applying a 3-inch circle, that in both light and definition it quite equalled the achromatic. With the full aperture, the companions of α Tauri and α Lyræ, the faint pair between ϵ^4 and ϵ^5 Lyræ, and the companion of α Serpentis, are seen with very little difficulty. The 5th star in the trapezium of Orion was often seen last winter; and on several fine nights the 6th, which is considered good work for a 5½-inch object glass.

On the night of June 5, 1865, I carefully observed the planets Jupiter and Saturn with the Hartwell Equatorial formerly used by Admiral Smyth in forming the *Bedford Catalogue*, and fully described in the *Cycle*, vol. i p. 338. This has $5\frac{9}{10}$ clear aperture, and of the highest excellence. I am not going to pretend that a 6½-inch mirror will furnish the splendid definition or light-grasping powers of this admirable instrument; but it is some consolation to possess an instrument that presents a picture in a great measure resembling the splendid view of planetary details I then enjoyed.

A word must also be said as to the comparative cost of the achromatic and reflector. I am not going to endorse the statement of a recent correspondent, that "a 6½-inch mirror need not cost more than 1*l.* 10*s.*;" and although some few may attain a reasonable share of success in the grinding and figuring of specula, yet I have looked in vain to see one of those who have attempted the task ever positively name any real test of optical excellence shown by the instruments so constructed. I have, however, seen the letter of a person who after having ground and silvered a 12-inch speculum, found, on testing, that, with a low power, it showed the belts and moons of Jupiter, and the lunar mountains (easily seen with a 1½-inch object glass), but with a high power was quite useless.

I need not remark on the contrast between such productions and the accurate mirrors made by Mr. With, and beautifully mounted by Mr. Browning: they speak for themselves; and it is quite obvious that in the expenditure of any given sum in the purchase of a reflector, the defining, light-grasping, and general optical efficiency will show a very great increase over what would have been obtained by expending the same amount in the purchase of an achromatic.

I am, Sir, yours, &c.,
Town's End Road, Chesham, Bucks, C. GROVER.
Nov. 15, 1868.

MOTION OF THE MOON.

Sir,—I happened to see in some old numbers of the *Register* the controversy about the motion of the Moon, whether or not it turns upon its axis, and it occurred to me that the indeterminate result of that controversy arose from the fact that *both sides* are right; and as I do not think this has ever been clearly stated, with your permission I will proceed to do so.

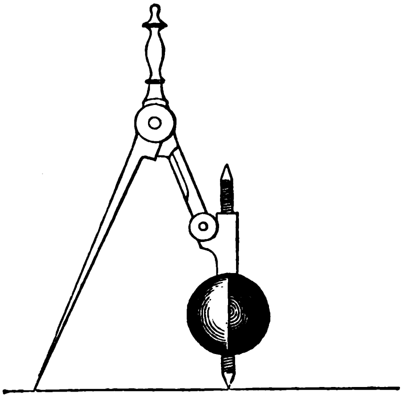
Mathematicians decompose the actual motion of a body into two motions, one of rotation another of translation, *not because there is any inherent necessity that the motion should be so resolved, but merely for facility of mental conception and mathematical treatment.* These therefore maintain that the Moon turns on her axis and that the axis has a motion of translation. Those who are not mathematicians do not resolve the motion, and they therefore maintain that the Moon does not turn on its axis.

Why should the one cavil at the other? In the case of a wheel rolling along a road, those who are not mathematicians would not certainly object to saying that the centre of the wheel had a motion of translation in a right line and a motion of rotation about the centre, yet they would then be doing the very thing they object to, namely decomposing, for facility of conception, the actual motion into two; to be true to themselves, they ought to consider the particles of the wheel as moving in cycloids and trochoids.

And on the other hand the mathematicians should allow that their opponents accurately describe the motion when they say that the whole of the Moon revolves round the Earth without any rotation on its own axis; for they consider the unresolved motion.

I am, Sir, your obedient servant,
Peckham: February 9, 1869. W. B. GIBBS.

REVOLUTION AND ROTATION ILLUSTRATED BY BALL AND COMPASSES.



When the Ball and Compasses are turned round on the point of the axis passing through the ball, the ball rotates; when turned round on the point of the other limb of the compasses, the ball revolves.

These are the two modes of turning round. Both are simple motions, each being a single movement; and each causes the ball to turn all sides to the spectators, but to present constantly the same hemisphere to the other limb of the compasses.

Revolution and Rotation.

In tracing a circle with a bow-pen or a pair of compasses, both limbs of the instrument simultaneously turn round the same centre; and while both face in succession every point of the horizon, each retains the same face to the other. A ball with one hemisphere red or black and the other white on a screw axis, substituted for the pencil, makes the effect of the two movements more conspicuous, demonstrating that each of them shows the same face to the other, but all sides to surrounding objects—one in consequence of its axial rotation about the fixed centre of the circle described by the other, and that other in consequence of its orbital revolution round the centre of rotation of the former. These movements exemplify the two simple ways of turning round, viz.:—axial rotation round a centre or axis within the body; and orbital revolution round a centre or axis not within the body, but more or less distant from it. Thus the Earth is said to revolve round the Sun once a year, while it rotates on its axis every day. This being the distinction between them, it is obvious that rotation may be regarded as the limit of revolution, and revolution the extension of rotation.

If the ball be rotated on its screw axis (as in screwing or unscrewing), the white and coloured hemispheres will alternately be turned towards the other limb of the compasses—thus affording an infallible test whether or not the ball turns on its axis.

Due consideration of this simple experiment ought to convince any one that if the Earth travels round the Moon, the latter turning round her own centre in the same time and in the same direction would have the effect of turning one hemisphere always towards the Earth, while turning all her surface to all surrounding objects except the Earth,—but that, if the Moon travelled round the Earth as alleged, turning round her own centre must have the reverse effect as regards the Earth, as it would cause every part of her surface to be turned towards the Earth (as well as towards all surrounding objects) in the course of each rotation; whether she turned round her axis or centre in the same direction as she travelled round the Earth, or in the contrary direction; and whether she thus rotated once in each circuit, or oftener, or not so often. These are the natural effects of turning round; as any one, to whom such results are not self-evident, ought to fully understand after studying what the experiment teaches.

57 Warren Street, Fitzroy Square, W. HENRY PERIGAL.

FACTS AND SPECULATIONS RELATING TO SATURN'S RING.

Sir,—Saturn may truly be said to be the most interesting, and possibly the most beautiful, of all the planets. This, no doubt, is in consequence of the wonderful appendage which it possesses, in addition to its globe and moons. Saturn's ring is an anomaly in the solar system; the only object of that kind with which the most powerful telescopes in existence have made us acquainted. It lies in the plane of the planet's equator, and the entire diameter of the outermost ring is more than 150,000 miles. Its appearance when seen from the earth greatly differs: sometimes it shows itself as a ring enclosing the planet; at other times it is seen as a line of light only; in fact, when its edge is turned towards us, none but the most powerful instruments can render it visible. At one time it was thought that this ring was solid, and single; that it is in reality composed of several rings is now certain; and, what is still more strange, those rings really seem to be undergoing change. Of late, very moderate telescopes have shown us a ring before unnoticed—a transparent one, on the inside of the bright ones before known. Through this ring the body of the planet is visible; but this *crape ring*, as it has been called, was not seen by Herschel or the astronomers of his day, though they possessed fine instruments and saw far more difficult objects in his system than that ring. Telescopes which will now show that ring with ease will not show the satellites which he discovered and frequently saw. That he should have overlooked the ring, if it then existed, is truly wonderful; and many think that at that time it was not formed, or that it must be more dense now than it was then. It is also questionable whether this ring is quite round. There are reasons to lead us to infer that the ring is in reality an ellipse, having Saturn's centre in one of its foci.

In 1827, Schwabe remarked that the ball lay west of the ring's centre. This was confirmed by Harding; and Struve, at Dorpat, measured it on six evenings with powers from 400 to 600, with the same result. All moderns who have measured the distances referred to agree that this eccentricity really exists.

But we are now told that the rings are all undergoing change; that the entire ring system is increasing in breadth, and at the same time the inner part is approaching the planet.

We must now leave the region of fact, and enter the field of conjecture.

What are those rings? Did they always form a part of Saturn's system, or are they the matter of a foreign body, which has paid old Saturn a visit, and which, when many cycles of centuries shall have passed away, may be looked for in vain? Strange as it may appear, I think it neither impossible, nor even improbable, that such may be the case. Let me give you my reasons for indulging such a conjecture.

And here I must introduce my old subject. "Comets again!" you say. Yes; and it may be that the work of comets in the economy of the universe is so varied that we may not have dreamt of all the work performed by them. And I think I may be able to show that even Saturn's rings may owe their existence to a comet: in fact, *that it is a comet*, seized by the attraction of Saturn, and held in his grasp, encircling him instead of following its former course around the sun.

Let me refer to the fact that, although it is probable that all comets come from the extreme limits of the solar system in the first instance, their aphelion distance at present is widely different—some having their aphelion point within the orbit of Jupiter, others passing outward, far beyond the orbits of the most distant planet; and hence it is by no means impossible that at some far remote period in the past the aphelion of some particular comet should have been just at the same distance from the sun as the distance of Saturn's orbit, and that the one should intersect the other, or at any rate come sufficiently close to each other for the attraction of the planet on the comet to have been greater than the sun's attraction at that time. Saturn would thus draw the comet to itself; but the momentum of the comet would be a projectile force, and carry it around the planet instead of into it. The comet, being at its greatest distance from the sun, would be, doubtless, greatly elongated; and the part which first came within the limits of Saturn's attraction would be first acted on, and be carried round in an orbit where the attractive force and centrifugal force balanced each other. Thus the preceding part of the comet would have made, perhaps, one, possibly several revolutions, before the last particles would be gathered in. In this case, a ring would have been formed round the planet, of yielding cometary matter, and its figure would necessarily be that of an ellipse, having the planet's centre as one of its foci.

If such has been the origin of Saturn's ring, that the outer part should be expanding, as a result of centrifugal force, might naturally be expected; and as it is likely that the ring matter would not be equally dense, we must expect to find it arranging itself in rings corresponding to the density of the different parts; and thus we may get an idea relating to the cause of the crape ring: the transparent gaseous one nearest the planet's body being least dense is less powerfully acted on by centrifugal force, and hence is nearest the centre of motion.

I have referred to these facts and fancies, hoping that some one may investigate the matter more fully; but for the present I have done.

I am, Sir, truly yours,
A. ELVINS.

ZETA CANCRI.

Sir,—Last June a letter appeared in the *Register* (p. 132), from the Rev. H. C. Key, on the distance of the close pairs in ζ *Cancri*, in which the author gives his reasons for believing that the distance of A. B. on the 7th May 1868 was only 0″·20. It so happened that, in answer to some enquirers, there was in the same number (p. 143), a note showing that in March preceding my 9-in. "With-Browning" Reflector had divided the pair well, with power about 350. I was therefore so surprised at Mr. Key's conclusions, that I determined on again examining the object the first opportunity. This came on the 23rd of December 1868, when the same instrument again divided this interesting pair, showing a clear blank space between round discs with power 320. Its distance must therefore be 0″·6 ±. By taking the configuration of the three stars C. A. B., and assuming the angle of pos. A. C. to be 140°, I estimated pos. A. B. 220° ±, so that B. has moved round A. in nine months about 3°. Notwithstanding the fact that the close pair is yet much more than 0″·2 apart, it will continue to be an object of interest until its orbital motion shall have been sufficiently observed to enable its period to be more correctly known.

I am, Sir, yours truly,
Earith, Hunts, Jan. 13, 1869. T. H. BUFFHAM.

MAGNIFYING POWERS; JUPITER'S SATELLITES, &c.

Sir,—I fully agree with Mr. Grover, in his remarks in your last number, having reference to the magnifying power required to obtain satisfactory views of the planets. I am of opinion that it is absolutely necessary to employ powers of at least 300 or 350 to successfully observe the minute details of those interesting objects. My 4¼-in. refractor, of 7 feet 4-in. focus, defines the planets excellently with 350 and 400, and I very seldom find it an advantage to use lower powers. The loss of light consequent on the employment of such high magnifiers does not materially affect the appearance of the object viewed. It is true, vibration is greatly increased and more difficulty is experienced in finding the object and keeping it well in the field of view, but these derogatory influences will be almost inappreciable if the air is steady and the telescope well mounted and provided with a finder.

With regard to the remarks of Mr. Hunt, respecting the visibility of Jupiter's satellites in daylight, I may say that I have very distinctly seen the satellites just before sunset on several occasions during the present month. On the 4th and 5th they were easily perceived about ten minutes before the sun disappeared below the horizon, and I have no doubt that they may be observed in full sunshine by those who are possessors of powerful equatorially-mounted telescopes. My instrument being merely provided with a garden stand, I occasionally find it difficult to detect the planet so early in the evening, but can generally bring it into the field of view after a few minutes' careful "sweeping."

On the above occasions the numerous belts of the planet were very sharply defined; the polar shadings were also excellently seen, as well as the shadow of the third satellite on the former evening. The most suitable time for observing the details of this planet is undoubtedly from sunset until three quarters of an hour after. During this period the small belts, &c., may be discerned with much greater distinctness than at a later hour. The planet was not a difficult object to see with the unassisted eye at 3.55 on the 4th inst.

I take this opportunity of making a correction in my letter on Jupiter in your last number. The word Eastern should be substituted for Western, in lines 9 and 30 from the top. In both these cases I did not take into consideration the fact that the image was inverted.

I am, Sir, truly yours,
WILLIAM F. DENNING.

Ashley Road, Bristol,
January 12, 1869.

JUPITER'S SATELLITES.

Sir,—Your correspondent "C." (Feb., p. 51) is kind enough to allow that those who believe they have seen a satellite of Jupiter without a telescope are honest, but deceived. It is not unimportant to the parties themselves, the correctness of their observing judgment being the point in question; and if wrong here they would be wrong elsewhere.

Your correspondent's implied argument elucidates no part of the matter. Reading figures at a distance is almost entirely dependent on the angle subtended. It is stated that in general an object must at least subtend an angle of 30″ to be visible at all; and to see its form a subtension of 60″ is necessary. But the first part of this rule is well known not to apply to very luminous objects on a dark ground, from the fact that the apparent size of stars is governed by their brightness, although indefinitely less than 1″ in true diameter. If "C." sees the third satellite with a power of 5 he sees only the *light*, not the *disk*, which is then only 7″·5 in the eye. It would require a power of 20 to see the disk. Thus then his comparison printed figures with these small points has nothing to do with the matter.

The fact is, that seeing this satellite at its greatest elongation is a matte of *method*. And with eyes of normal quality the principal difference i effectiveness with the telescope mainly arises from difference of metho or practice. *This* question is not trivial, but is probably much more important than most deem it.

Permit me to refer "C." to p. 216 of the *Register* for October 1867.

I am, Sir, yours truly,

Earith, Hunts: Feb. 12, 1869. T. H. BUFFHAM.

P.S. Mercury was splendidly visible on the evening of the 5th, and attracted attention before it was imagined to be the planet.

WINNECKE'S PERIODICAL COMET OF 1858.

Sir,—This body is now returning to our parts of space. It will pass through perihelion about July 3.

The following Ephemeris is by Mr. Linsser of Pulkowa:—

Berlin Mean Midnight.

	R.A.		Decl.	
1869.	h.	m.	°	′
March 1	11	31·2	+21	31
2	11	29·9	21	51
3	11	28·6	22	11
4	11	27·3	22	32
5	11	25·9	22	52
6	11	24·5	23	13
7	11	23·0	23	33
8	11	21·5	23	54
9	11	20·0	24	15
10	11	18·4	24	35
11	11	16·7	24	56
12	11	15·0	25	17
13	11	13·3	25	38
14	11	11·6	25	59
15	11	9·8	26	19
16	11	8·0	26	39
17	11	6·1	26	59
18	11	4·3	27	19
19	11	2·4	27	39
20	11	0·5	27	59
21	10	58·6	28	18
22	10	56·6	28	37
23	10	54·7	28	56
24	10	52·8	29	14
25	10	50·8	29	31
26	10	48·8	29	48
27	10	46·8	30	5
28	10	44·8	30	22
29	10	42·9	30	38
30	10	40·9	30	54
31	10	38·9	31	9

When the Comet comes more within reach, I will supplement the abo by some information for observers unprovided with equatorials.

Bickley, Kent: GEORGE F. CHAMBERS.
Feb. 15, 1869.

COMET II. 1867.

The following elliptic elements for the orbit of this comet have been calculated by M. Sandberg.

Perihelion passage = 1867, May, 23·95
° ′
Longitude of Perihelion = 134 59
Longitude of Ascending Node = 101 10
Inclination = 6 24
Angle of eccentricity = 30 38
Mean Daily Motion = 623″
Period = 2,080 days.

The comet does not appear to be identical with any former ones, as was once supposed.

COMPANION OF ALDEBARAN.—It may interest your correspondent W. J. H. B. to know that the comes to "Aldebaran" can be seen with less aperture than 2¾ inches. In 1863 I saw it distinctly with a 3½-inch lens reduced to 2⅓, power 350, and could just see it with the same lens reduced to 2¼ inches. In January last year I saw it plainly with a 6-inch lens reduced to 2 inches, power 220, and got an angle of position 34°·9 by putting the wire over the big star and then turning the position-circle round until the wire put the small star out. Afterwards, with the full aperture and a dark field, I got a position angle of 35°·1.

I think that these small stars are often not seen from want of magnifying power quite as much as from want of light. Doubtless some of them will not stand a high magnifying power, being from some cause or other put out by it; but in many cases the small stars near the larger ones have been missed by observers not having, or not using, the higher power eye-pieces.

J.

LIST OF SUBSCRIBERS—Name received since our last number.

Felkin, W., Esq., Jun., Beeston, Notts.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To June 1868.

Gribble, Rev. C. B.

To December 1868.

De La Rue, W.
Erck, W.
Fletcher, I.
Harker, J. W.
Little, W.
Watson, J.

To March 1869.

Heelis, J.
Linwood, Rev. W.
Payne, R. W.
Thrustans, J.

To April 1869.

Knobel, E. B.

To June 1869.

Banks, W. L.
Cook, J.
Lancaster, J. L.
Lancaster, W.
Oldfield, W.
Potter, T.
Troward, C.

To September 1869.

Brothers, A.

To December 1869.

Adams, S.
Barber, J. T.
Bowman, E.
Collingwood, E. J.
Deey, Rev. A.
Felkin, W.
Gould, Rev. R. J.
Johnson, R. C.
Knott, G.
Lamb, W.
Parnell, J.
Perigal, H.
Shuter, J.
Turberville, H.
Vernon, G. V.
Vines, D.
Whitbread, S. C.
Worthington, F.

Rump, H. R., 6*s*.

February 25, 1869. Subscriptions after this date in our next.

NOTICE TO CORRESPONDENTS.

ERRATA. In No. 74, page 48, line 20 from bottom, for *not* read *next*; page 53, line 9 for Sept. 28 read Sept. 23, and for *being* read *very*.

We are still compelled to defer some communications.

ASTRONOMICAL OCCURRENCES FOR MARCH 1869.

Date		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Mars
Mon	1		Sidereal Time at Mean Noon, 22 37 18·7	2nd Oc. D.	8 35	10 52·7
Tues	2		Meridian passage of the Sun, 12m. 17s. after Mean Noon	3rd Tr. I.	6 50	10 47·5
Wed	3			2nd Tr. E. ,, Sh. E.	6 20 7 48	10 42·4
Thur	4	15 52 17 6 17 43 21 1	Occultation of 29 Ophiuchi Reappearance of ditto Moon's Last Quarter Conjunction of Moon and Uranus, 2° 55′ S.			10 37·3
Fri	5			1st Oc. D.	8 25	10 32·2
Sat	6		Illuminated portion of disk of Venus, 0·963	1st Sh. I. ,, Tr. E. ,, Sh. E.	6 17 7 49 8 31	10 27·2
Sun	7			1st Ec. R.	5 48 40	10 22·3
Mon	8					10 17·4
Tues	9					10 12·5
Wed	10	9 43	Conjunction of Moon and Mercury, 0° 59′ N.	2nd Tr. I. ,, Sh. I.	6 39 8 0	10 7·7
Thur	11	11 7	Conjunction of Moon and Venus, 0° 29′ N.			10 2·9
Fri	12	20 46	● New Moon			9 58·2
Sat	13		Saturn's Ring: Major Axis=38″ Minor Axis=17″	3rd Ec. R. 1st Tr. I. ,, Sh. I.	6 25 47 7 26 8 13	9 53·6
Sun	14	23 28	Conjunction of Moon and Jupiter, 3° 46′ N.	1st Ec. R.	7 43 46	9 49·0
Mon	15		Illuminated portion of disk of Mars, 0·964			9 44·4

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Tues	16		Sidereal Time at Mean Noon, 23 36 26·9			Mars — 9 39·9
Wed	17	17 52	Greatest westerly elongation of Mercury, 27° 42′			9 35·5
Thur	18	22 54 23 50	Occultation of Aldebaran (1) Reappearance of ditto			9 31·1
Fri	19	 11 11	Meridian Passage of the Sun, 7m. 51s. after Mean Noon Near approach of Moon to B.A.C. 1526 (6)	2nd Ec. R.	7 8 31	Moon — 4 49·0
Sat	20	17 54	☽ Moon's First Quarter	The Satellites of Jupiter are invisible from March 19 until May 14, Jupiter being too near the Sun.		5 41·1
Sun	21	16 58	Conjunction of Moon and Uranus, 3° 12′ N.			6 35·9
Mon	22	9 24 10 31	Occultation of *g* Geminorum (5½) Reappearance of ditto			7 32·3
Tues	23	15 3 15 32	Occultation of ο² Cancri (6) Reappearance of ditto			8 30·7
Wed	24	0 14 15 16 16 6	Conjunction of Moon and Mars, 3° 32′ N. Occultation of ν Leonis (5) Reappearance of ditto			9 28·8
Thur	25					10 26·1
Fri	26					11 22·4
Sat	27	9 33	○ Full Moon			12 17·7
Sun	28	7 37 8 30	Occultation of 80 Virginis (6) Reappearance of ditto			Mars — 8 49·9
Mon	29					8 46·1
Tues	30	10 49 11 52 15 42 16 51	Occultation of γ Libræ (4) Reappearance of ditto Occultation of η Libræ (6) Reappearance of ditto			8 42·3
Wed	31					8 38·6

THE PLANETS FOR MARCH.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	21 37 18	−12 53	9″·0	22 40·5
	20th	22 23 27	11 39½	7″·0	22 27·5
Venus	5th	22 8 39	−12 43½	10″·2	23 11·8
	20th	23 19 7	5 57½	9″·8	23 23·1
Mars	5th	9 27 3	+19 22	15″·3	10 32·2
	20th	9 16 13	19 36½	13″·8	9 22·4
Saturn	5th	17 3 25	−21 9½	15″·0	18 7·4
	20th	17 4 48	21 9½	15″·4	17 9·7
Uranus	6th	6 58 44	+23 12	4″·0	8 0·4
	22nd	6 58 19	23 12½	—	6 57·1

THE LATE LUNAR ECLIPSE.—From the *Levant Herald* we extract the following notice of this eclipse, which was not seen in this country, as far as we have heard, on account of clouds:—"The moon entered the earth's shadow on Thursday morning at 2h. 25m. The maximum of the eclipse was at 3h. 34m. Nearly half the moon's surface was obscured. The last trace of the shadow was seen at 4h. 45m.—C. B. G.

NATIONAL SUPPORT OF ASTRONOMY.—The staff of the Greenwich observatory consists of the Astronomer-Royal (1,000*l.*) and six assistants, at from 400*l.* to 170*l.*, and that of the observatory at the Cape of an astronomer (600*l.*), and two assistants (400*l.* and 250*l.*), with two other assistants (150*l.* and 100), in the magnetic department. The magnetic department at Greenwich has a superintendent (300*l.*), with assistants (270*l.*). The *Nautical Almanac* has a superintendent (500*l.*), a chief assistant (300*l.*), and ten computers (1,399*l.*); the number of *Nautical Almanacs* sold, in the five years, 1863 to 1867, was 106,883; from *Whitaker's Almanack* for 1869, p. 149. Whilst reformation in the national expenditure is no doubt in various cases imperatively called for, no one can complain of the moderate cost (represented by the above figures) at which an immense amount of refined skill and patient labour are secured to the country. It were desirable, rather, that the labourers in some cases were better remunerated and more in number. *Whitaker's Almanack* is probably by this time well known to many as perhaps the best one there is for general purposes. For special objects, Gutch and Hannay are as valuable as ever.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

OBSERVING SEATS.

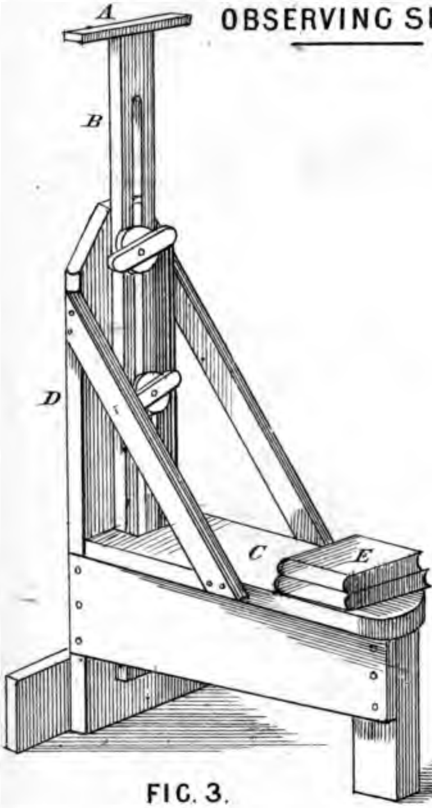


FIG. 3.

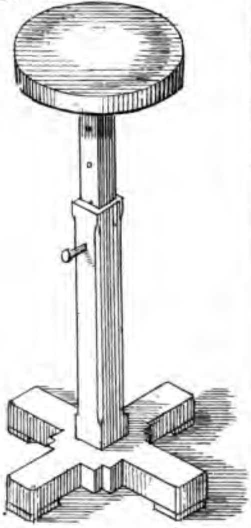


FIG. 1.

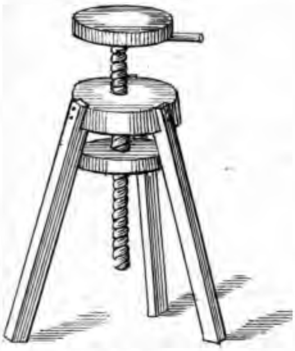


FIG. 4.

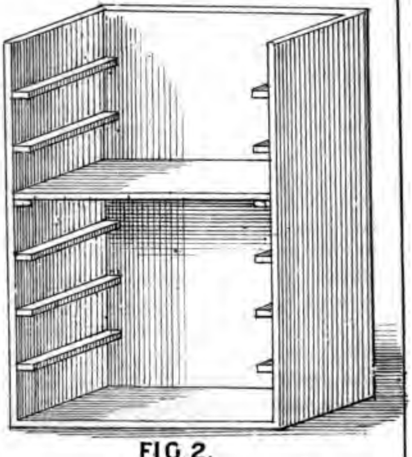
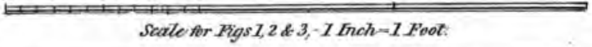


FIG. 2.



Scale for Figs 1, 2 & 3, - 1 Inch = 1 Foot.

SPOTTISWOODE & Co. LITHOGRS. LONDON

The Astronomical Register.

No. 76. APRIL. 1869.

OBSERVING SEATS.

In making astronomical observations, one of the greatest points to be secured is *steadiness*; steadiness, not only for the instrument, but for the observer, as without it no good results can be hoped for, however powerful or excellent the instrument, or favourable the circumstances of the occasion. With regard to instrumental steadiness, much is now done which formerly was neglected, and in the present day the efficient mountings which are to be obtained from our first-class optical engineers secure an almost perfect absence of vibration in the use of large instruments, provided that extraordinary causes of tremor do not come into play. In most cases, also, smaller telescopes can now be procured, which are greatly in advance in respect to steadiness of what used formerly to be endured as an almost necessary evil. The present remarks, however, are intended to apply to the steady position which the observer should occupy while using the instrument; and it cannot fail to have been remarked by visitors to many amateur observing-rooms that the means for obtaining this desirable end are very frequently entirely neglected. A telescope of eight or ten feet in length is often to be met with unprovided with more than a chair, or at most a small set of steps, for the use of the observer; sometimes, but rarely, a pole is added to the steps by which what may be called an *unsteady* amount of steadiness may be attained. We need not say, of course, that in the great public observatories, and in many private ones where large instruments are employed, means of the most elaborate character are in use for the comfort of the observer; it is to private observing-rooms of a more moderate kind that our remarks principally apply, and in these, as we have said, it frequently happens that the instrument absorbs the entire attention, to the neglect of the proper facilities for using it.

The requirements of an observer when using a telescope, however small the instrument may be, are, in the first place, that the body should be in a position of ease; secondly, that the head should be supported at a proper height for looking through the telescope; and thirdly, that one or both hands should be at liberty for using the micrometer or the adjusting handles. There should also be easy methods of altering the position or height of the supports for the head or body. We have received several communications on this subject, and present to our readers drawings of some observing seats. The requirements noticed above are, however, not entirely fulfilled in any of them; but as improvements may be suggested, we consider the whole matter well worthy of attention.

In the plate illustrating the subject, the figure No. 1 represents an observing seat adopted by Mr. T. Wilson, of Thornton-in-Craven near Skipton, who describes it as follows:—

Having noticed in the *Intellectual Observer* some time ago a description of an observatory stool or seat, costing something like 35*s.*, over which one that I have had in use some years seems, so far as I can judge by that description, to have greatly the advantage in respect of portability, small cost, (about 8*s.*), &c., I now enclose an isometric sketch of the same, by which, and the few accompanying notes, a similar, or even an improvement on it might be easily made. The stool is constructed of well-seasoned American birch, the various parts carefully jointed and put together with screws. The holes or hollows in the stem of the movable seat are made at such distances from each other, that when any one clears the top of the socket the nose of the thumb-screw will be sure to find its way into the next below. If this seat had to be used on an uneven floor, and perhaps in any case, it would be a decided improvement to make it with a tripodean base, instead of having four points of support, thus securing firmness under any circumstances.

Fig. 2 illustrates a contrivance used by M. Guyon, of Ventnor, Isle of Wight, which is thus described:—

The numerous class of observers who carry on their astronomical operations in the garden frequently feel the want of an inexpensive seat of variable height, in place of the discomfort and unsteadiness of a standing, or often crouching position. A music-stool may sometimes be available, but its range of elevation is limited, and the following suggestion may possibly be serviceable to some who seek a cheaper expedient than Mr. Slack's more perfect contrivance. A wooden box, like any other solid, has of course three dimensions; and one, of say 24 inches long, 17 wide, and 10 deep would furnish a seat of any of these altitudes, according to whether the top, side, or end were uppermost. Greater variation might be attained by keeping a well-stuffed hassock in the box, and supposing the former to be 4 inches deep, the scale of elevations would be 4, 10, 14, 17, 21, 24, and 28 inches, sufficient probably for any position of the instrument, and for all sizes of observers, from those of the first magnitude downwards. A slight advance on the primitive simplicity of this contrivance would be made by taking a box somewhat larger than the above, removing the lid and one of the ends, and then nailing battens or bars of wood transversely on the inside of each of its sides, the battens parallel to each other, and 3 or 4 inches apart; or stout pegs might be inserted in the same positions. The box being placed with the open end upwards, a loose board (which the removed end might furnish), resting on the battens or pegs at the elevation required—precisely like a shelf in an ordinary bookcase—would afford the desired seat for the observer. It need scarcely be observed that blocks of wood nailed on as feet would give greater steadiness to the machine on uneven ground.

Fig. 3 is a representation of a seat adopted by the Editor of the *Register*: its construction will be readily apprehended from the drawing.

This seat is inexpensive, and, in fact, can be readily put together by an amateur carpenter. The support for the head (A) is fixed to the top of a long piece of deal (B), in which a slit is cut nearly the whole length. This piece of deal passes through an aperture in the seat (C), and can be secured at any desired height to the back (D) by means of two large wooden nuts and washers, which work on two ordinary wood screws inserted in the back. The surface of the wood of which the back and the long piece B are formed is left unplaned where they are in contact, and by this means a very slight tightening of the nuts causes a firm adhesion in any position. The observer sits across the end of the seat, facing the back (D), and rests his chin on the left hand, on the head support (A). By means of a few books or pieces of wood at (E), his position may be raised as required. A screw seat, similar to a music-stool (fig. 4), the screw working in the seat (C), has been suggested in place of the books or pieces of wood (E). This seat has been found to answer exceedingly well, except when the altitude of the object is very great. The head, supported by the hands, on the piece (A), is quite steady, and if the telescope is driven by clockwork, the comfort of this contrivance for observing is very great.

Fig. 4 is a rough representation of a music stool, with screw seat, to be used for observing.

This is provided with a handle by which to turn the seat round, to raise or lower it. Mr. Williams, of Holloway, who uses a seat of the kind, recommends it as being, on the whole, the most handy contrivance for an observer with a small telescope.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868–9.

Fifth Meeting, March 12, 1869.

Admiral Manners, *President*, in the Chair.

Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Minutes of the last ordinary meeting were read and confirmed.

Sixty-five presents were announced, and the thanks of the Meeting given to the respective donors.

Rev. R. R. Davies, Charles Barton, Esq.,
Col. Addison, Lieut. Geo. Strachan, and
Rev. W. E. Wall,

were balloted for, and duly elected Fellows of the Society.

The following papers were read wholly or in part:—

On the Transit of Mercury: by Mr. Abbott.

The times of the phenomena and diagrams were given.

On the same: by Mr. Barneby.

Having read many differing accounts of this Transit, the author thought a description of what was seen with his large refractor might be useful. The sky was cloudless, and the planet showing very black on the Sun's disc. He saw no bright spot on Mercury nor any aurora round it, but several times observed a black stroke from it like zigzag lightning. This he believes to have been optical only. No ligament to the Sun's edge was thrown out, but the planet's limb became serrated as it approached that of the Sun. With respect to the telescope, the author mentions that he has seen γ^2 Andromedæ separated in daylight sufficient to read the circles of his instrument, and that the colours were remarkably distinct and accurate. This was with 9-inches aperture and power 750.

On the same: by Sir T. Maclear.

This paper contained measures of the positions of Mercury on the Sun's disc relative to the solar limbs, and which furnished a correction for the differences of R.A. of the Sun and Mercury. This, however, turned out to be very small.

On the Observations of the Transit of Venus, 1874: by Mr. Airy.

In the *Comptes Rendus* is a paper by M. Puizeau on the Astronomer-Royal's memoir, in which the author argues that this transit might be observed by taking the differences of the interval of the whole passage at two stations, and points out the places adapted for the purpose. Mr. Airy is still of opinion that the plan he suggested of observing the ingress and egress as separate phenomena is better calculated to ensure success, and requiring only two instead of four observations at each station; but he points out that he had not been unmindful of the other method, and in his paper of 1857 had given the necessary information, and named the places suitable for the observations. He would be glad to find those observations made, although later consideration had led him to prefer the alternative plan.

On the Meteoric Shower of November 1868: by Sir T. Maclear.

This paper gives the result of the watch kept up on November 13. The first meteor seen was at 13h. 18m. 30s. The maximum occurred at 14h. 42m., and the last was seen at 16h. 20m. when day was breaking. The total number was 1024. A dense haze prevented their being traced back to the radiant point, but it was somewhere between ζ and γ Leonis.

On Personality in the Determination of the line of Collimation in a Transit: by Mr. Stone.

Any personality noticed between several observers casts a certain amount of doubt upon all the observations. It was, therefore, thought desirable to investigate this subject as connected with the observations for collimation made at Greenwich. This correction is tested every day, except Sunday. Upon discussing the differences between the measures of the different observers, the result shows that the discordances from the mean are perfectly insensible.

Capt. Noble said that the delicate enquiry detailed in this paper reminded him of the investigation made by Mr. Stone some years ago, which showed that the horizontal spider lines of the instrument formed a catenary curve, a thing which had never been suspected.

Occultations observed at Liverpool: by Mr. Joynson.

The stars occulted were Aldebaran, and 115, 119, and 120 Tauri. The times were given.

Note on the Attraction of Ellipsoids: by Mr. Cayley.

The author gave an oral and graphic explanation of this paper.

On the Total Solar Eclipse of August 7, 1869: by Mr. Hind.

This communication consisted of tables for finding the limits of totality for the eclipse.

The President announced that Mr. Brayley would deliver two lectures at the London Institution, on March 22 and 25, at 6 o'clock; the subjects being "The Nature of the Sun, as recently investigated by Astronomers and Spectroscopists," and "The Total Eclipse of August 1868," to which any Fellow of the Society or their friends would be admitted on producing their cards.

On an Improved Method of Mounting Finders: by Mr. Browning.

This might seem a small matter to bring forward, but we had lately had some remarkable slips, and nearly remarkable losses from the want of proper adjustment. The author's attention had lately been drawn to this subject both originally and by a letter from Mr. Piazzi Smyth. Several plans had suggested themselves, but the last and simplest was the best. There were two methods in use at present. The oldest was to support the finder in two rings standing on legs attached to the telescope. The finder was loose in the rings, and sustained by three screws pushing against each other. This system had the disadvantage of not allowing a clear view along the finder, and any motion caused a jar which threw the finder out of adjustment through standing on these points. Rough treatment was the usual lot of such instruments, many persons being in the habit of moving their equatorials by pulling at the finders, with results that might be imagined. A more recent mounting had the finder in close fitting rings, with a diaphragm carrying the cross wires, moved by screws. This limited the field of view, and could still be put out of adjustment very easily. The plan now proposed had the finder bedded in circular Y's, and moved vertically by a screw through the front one, and horizontally by antagonistic screws at the back one. A clear view outside was thus preserved, the full aperture of the object-glass used, and the cross-wires kept steady. With three screws the result of moving them cannot be seen until all are touched, and much time is lost in adjusting; but with the two motions the necessary elevation is first given, and then the lateral movement at once finishes the operation. There is no strain during the adjustment, and the new mode ought to make no difference in the price.

On an Extensive Train of Sun Spots: by Mr. Browning.

The author exhibited a small drawing and a large rough diagram of a remarkable group of spots seen last Sunday morning, and drawn and measured by him. The definition being bad, the aperture of the telescope was reduced to 6 inches, and a plate of silvered glass placed on the tube being a modification of Foucault's silvered object-glass. The train of spots was of enormous dimensions, covering 88,580 miles from east to west, and 27,130 miles from north to south. One portion of the group had very much the appearance of a pair of compasses. Other spots were seen, but not drawn. Near the limb the penumbra was almost lost, and the faculæ encroached on the umbra.

Mr. Howlett said he was unable to make very minute observations of this group on Sunday from want of time, but would state what he saw. The size of the spots was very nearly that which had been stated. There was an absence of the usual striation of the penumbra, and the umbra was lighter than in general. In fact, a lady to whom he showed the group, by projection, called the penumbra "diaphanous." There certainly was something like a pair of compasses, and in one of the speaker's former drawings he found a resemblance to a pair of tongs. The reason of the faculæ appearing brighter as they approach the sun's limb or of only being visible there is, that they are probably situated above the mean level of the sun, being either mountains of faculous matter or clouds floating above (but the latter is not likely, when we consider their conformity to the spots); and as near the limb the solar atmosphere is seen in much greater depth and the faculæ are brighter than the general surface of the sun, near the edge this general light is diminished by the greater thickness of atmosphere and the faculæ become comparatively more visible. Just now the faculæ are brighter than usual, and seen more towards the centre of the disc than in general. The lucules or smaller patches of faculous matter are also brighter than usual, and deserve attention and observation.

Mr. Browning: When I observed the group, it was near the centre of the sun, so that it may be seen for some days yet.

Mr. Howlett: It is very near the edge now.

Mr. Lockyer: I had the opportunity of observing this group at the same time, but was principally engaged in asking it other questions. Still, I remarked that one portion was darker than the remainder, and I also saw Mr. Dawes's nucleus.

The bridges of luminous matter were all fed from the same part of the photosphere, looking like the trunk of a great oak tree throwing out branches. The portion where the nucleus was developed gave in the spectroscope results different to the other parts. The difference between the darker and lighter parts was very marked. There were also great differences in the spectrum of one part and another. In some places the general and elective absorption was so great as to produce almost a black bar, while in others the lines indicative of certain substances could be seen. It will be better to defer further remarks until we know more, as the difficulties of the subject are very great.

Mr. Brayley said he should be obliged if Mr. Howlett would explain the word "diaphanous" used by him.

The President: I understood it was used by Mr. Howlett's friend.

Mr. Howlett: Yes, and not endorsed by me.

Mr. Brayley also objected to the use of the word "clouds" in speaking of solar phenomena, as the word had misled us too long.

Mr. Lockyer enquired the reason of the objection.

Mr. Brayley replied that it gave the impression of matter in a state of condensation, like our watery clouds, suspended in a gaseous atmosphere, which would not apply to the sun's constitution.

Mr. Lockyer: Having seen the prominences by Mr. Huggins's method of viewing them, I am afraid we must continue the use of the word, for I know not how otherwise to describe the appearance than as that of a fleecy cloud.

Mr. Brayley: The remark of Mr. Lockyer entirely confirms my view. In appearance there is nothing more like banks of cloud than the sierras round the sun's edge, but they have not the constitution of our clouds. The trains of meteors might as well be called clouds, though known to be incandescent solid matter.

On the Aden and Guntoor Photographs of the Total Solar Eclipse: by Mr. De la Rue.

In his recent paper the author had called attention to the difference in the direction of the *great horn* as seen at Aden and other places, and had suggested that it might arise from the axial rotation of the prominence during the observations. This depended on the accuracy of the drawing given in '*The Engineer*' of the Aden Photograph, and it was not possible to test this until the pictures themselves arrived. Mr. De la Rue has now been able to compare the Aden Photograph No. 1 with the Guntoor No. 2, and finds but little difference, while the Aden picture differs largely from the engraving said to represent it, the horn being curved the wrong way in the latter. The hypothesis suggested is therefore not supported by the photographs; although there was some change in the 40 minutes, still it may not be due to axial rotation.

Capt. Noble said that woodcuts were a very bad medium for the reproduction of drawings, and instanced the distortion of his views of solar faculæ in a paper of some years ago.

On the Rotation of Mars: by Mr. Proctor.

The author, having heard from Mr. Browning that he hoped to obtain drawings of Mars at the recent opposition, requested him to observe very carefully the passage of a central spot, in order to test the rotation period which Mr. Proctor had deduced from an examination of a very lengthened series of observations, beginning with the drawings of Hooke in 1666, down to those of Dawes and Browning. The pictures by Hooke, though not made for this special purpose, are more accurate than those of the 17th century in general. The result of the last opposition is to confirm the period formerly arrived at, viz. 24h. 37m. 22·735s. Professor Kaiser's period would throw Hooke's drawing out about 2 hours, which is not likely to be the case; while Beer and Mädler's period of 24h. 37m. 23·8s. is disposed of by Sir J. Herschel's drawing, although it would agree with Hooke's if one rotation were left out in the long interval of 200 years.

The President read a letter from P. Secchi to him, dated March 5th, *on the Constitution of the Sun*, in which he stated that careful examination had shown him a very thin stratum round the sun, which gave a continuous spectrum.

A paper of his on the subject had appeared in the *Comptes Rendus.*

Mr. Huggins: It is obvious that when the edge of the sun is seen, if Fraunhofer's lines are produced by vapours lying beyond the solid matter, there ought to be a layer just above the edge, which would give Fraunhofer's lines reversed; that is, bright lines instead of dark ones. Mr. De la Rue from his photographs has expected that something would be seen between the sun's edge and the prominences, and Mr. Stoney has written me, suggesting that there should be a line of light between the solar edge and the mass of hydrogen gas. Perhaps the bright lines of such a stratum are so numerous and close as to give Secchi the idea of a continuous spectrum. I have not myself been able to detect anything between the sun and the bright lines of the prominences, but the latter sometimes appear to project on the sun's disc. The atmosphere has however been bad here, and its worst effects are seen at the sun's edge. As far as I understand Secchi's paper, he has seen in the spectroscope, first, the ordinary solar spectrum, then a narrow one above, apparently continuous (at any rate having no dark lines), and upon that the bright lines of the prominences. I have not been able to detect this thin line, but Secchi's statement is very interesting. It agrees with what De la Rue said should be seen, and what Stoney suggested on theoretical grounds. The photosphere being solid or liquid clouds, or masses of particles of solid or liquid matter, Mr. Stoney thinks a large part may be carbon in vapour. The vapours round the photosphere give the dark lines; and though nothing is detected by me between the sun's edge and the bright lines of the prominences, these vapours of iron and other metals must be luminous, and should give bright lines when the photosphere is not behind them.

While speaking, I may perhaps be permitted to mention some experiments I made two or three years ago, and as to which I have lately sent a short paper to the Royal Society. They referred to the heat which reaches us from the stars, and which I thought more likely to be evident than that reflected from the moon. I did accordingly obtain undoubted indications of the effects of this heat by thermoelectric piles in the focus of my telescope, from Sirius, Pollux and Regulus, but I have not followed up the subject, hoping to obtain improved apparatus presently and then get quantitative results; but as it may be some considerable time before I resume the observations, it has been thought right to put the experiments made on record.

Mr. Browning: Probably the bright lines appear projected on the sun through the boiling so often seen at the edge; and may not the same cause produce the apparently continuous spectrum?

Mr. Huggins: I should be more disposed to attribute the projection to irradiation than boiling.

Mr. Stone said that, without any knowledge of Mr. Huggins's researches on the heat of the stars, he had turned his attention to the subject, and gone to considerable expense for apparatus, with which he got indications of success before he heard of what Mr. H. was doing.

Mr. Huggins expressed his regret at not having made known his results earlier, and proceeded to describe his method of viewing the solar prominences without an eclipse. In one plan a spectroscope is used, and the edge of the sun placed in the jaws of the slit. Another slit is placed in the focus of the small telescope used for viewing the spectrum, and the sun's edge and any prominences there ought to be distinctly seen. It is, however, necessary to limit the light nearly to one refrangibility, that is, of the same kind as the line to be observed; and a piece of deep ruby glass being used for this purpose, the outline of the prominence becomes visible. In another plan the sun's image is not made coincident with the jaws of the slit, but the prisms and the eye-piece of the telescope are taken away and a narrow slit substituted. By this passage through two narrow slits the light is reduced to almost that of one refrangibility only, and suns of any colour of the spectrum can thus be viewed and magnified by a separate small telescope. The narrowness of the slits produces diffraction of the images, which obliterates detail at the sides, but in one position a part of the edge can be clearly seen and any prominences made out, and the solar edge examined round in this way. The plan with the coloured glass promises to succeed best. Mr. H. has got a coloured glass which cuts off nearly all the light, except about the line C, and is very convenient and pleasant. Unfortunately, cobalt glass gives a dark band just where the line C is situated.

Mr. Howlett had some coloured glass that left only a deep red band, and would probably be eminently suited for the purpose, which he would send to Mr. Huggins.

Mr. Browning, reverting to the sun spots described by him, said that Mr. Lockyer and Mr. Howlett described the groups as continuous, but after two hours' examination he found narrow breaks.

Mr. Howlett: I only saw the spots about 8 o'clock.

Capt. Noble: At 2h. 30m. to 3h. they appeared continuous when projected on paper.

Mr. Huggins wished to mention that he found, on corresponding with Mr. J. C. Maxwell, that this gentleman two or three years ago, in his experiments on compound colours, had employed two narrow slits to procure light of one refrangibility.

The President expressed his own sense of gratitude, which he believed was shared by all the Fellows, to Mr. Huggins for allowing them to participate in his discoveries, by his interesting communications.

On the Transit of Venus in 1874: by Mr. Proctor.

Mr. Talmage enquired whether anyone had seen Winnecke's Periodical Comet, or knew of any corrections of its Ephemeris, as he had looked for it in vain.

The meeting then adjourned.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

PAST AND FUTURE SOLAR ECLIPSES.

Sir,—I remarked in a late number of the *Astronomical Register* a reference to Rothman's calculation of the Chinese Eclipse which led to the discomfiture of Ho and Hi. That calculation, however, is worthless, and was shown to be so by M. Largeteau a quarter of a century since. (Conn. des Temps, 1846. Additions, p. 28.) Rothman committed the great blunder of *subtracting* the longitude of Ngan-i-hein from the hour of conjunction in Paris time, instead of adding it. The Eclipse to which his calculations refer was not visible at all in China.

The Eclipse of 1887, to which one of your correspondents alludes, will *not* be visible in its totality in this country. Some years since Mr. Farley was kind enough to calculate for me the circumstances of this Eclipse, and I now beg to send you the results obtained from the tables of Carlini and Burckhardt:—

	d.	h.	m.	s.
Greenwich M.T. of ☌ in Right Ascension . Aug.	18	17	13	48
R.A. of Sun and Moon		9	52	30·49

		°	′	″
☾ Decl.	+	13	33	18·6
☉ „	+	12	54	8·8
☾ Hor. Mot. in R.A.			36	38·4
☉ „ „			2	19·5
☾ Hor. Mot. in Decl.			−9	13·0
☉ „ „			−0	48·8
☾ Horizontal Parallax			60	13·7
☉ „ „			0	8·5
☾ True Semidiameter			16	26·9
☉ „ „			15	50·6

Whence the path of the central line was as below:—

G.M.T. h. m.	Long. ° ′	Lat. ° ′	G.M.T. h. m.	Long. ° ′	Lat. ° ′
16 9·5	11 46 E.	51 42 N.	17 39·5	117 5 E.	48 45 N.
10·5	22 20	54 1	17 57·5	126 3	44 36
13·5	33 18	55 59	18 13·5	135 2	40 30
18·5	44 43	57 28	18 26·5	141 17	36 45
25·5	56 27	58 19	18 35·5	147 24	33 47
34·5	68 21	58 27	18 42·5	153 36	31 5
16 47·5	80 57	57 9	18 47·5	160 3	28 38
17 3·5	95 19	55 32	18 50·5	166 51	26 28
13·5	102 26	53 20	18 51·5	174 0	24 36
21·5	107 12	52 26			

So that the zone of totality does not reach our shores. A special calculation for Greenwich shows that the partial eclipse will end there at 17h. 3m. 48s., the sun rising at 16h. 47m.

The following are approximate positions at which the Eclipse will end at sunrise:—

Long.		Lat.		Long.		Lat.	
°	′	°	′	°	′	°	′
6	4 W.	55	30 N.	0	46 E.	48	15 N.
5	13	54	40	1	25	47	28
4	23	53	51	2	3	46	42
3	35	53	3	2	40	45	57
2	48	52	14	3	17	45	12
2	3	51	25	3	52	44	27
1	20	50	37	4	26	43	42
0	37 W.	49	49	4	58 E.	42	58 N.
0	5 E.	49	2				

Long ago I read in some popular work that the Eclipse of 1916, February 3, would be total in England. I have had the curiosity to calculate a few of the circumstances of this Eclipse, employing also the tables of Carlini and Burckhardt. I found:—

	d.		h.	m.	s.
Greenwich M.T. of ☌ in Right Ascension, Feb.	3	.	4	20	33

At 4^h *Paris* Mean Time.

		°	′	″		′	″		
☾ R.A.	.	315	41	44	+	(35	41)	×	t.
☾ Decl.	.	− 16	20	35	+	(13	49)	×	t.
☉ R.A.	.	315	58	15	+	(2	32)	×	t.
☉ Decl.	.	− 16	46	43	+	(0	43)	×	t.

	′	″
☾ Horizontal Parallax . .	60	11·1
☉ ” ” . .		8·7

	°	′	°	′
Central Eclipse at Noon in .	61	40 W.	16	16 N.
Central Eclipse ends in . .	9	32 W.	49	40 N.

The following are additional points in the central line:—

Long.	46° 20′ W.	30° 0′ N.
	29° 47′ W.	41° 6′ N.

Consequently the totality is not visible in this country.

I am, dear Sir, yours very truly,
J. R. HIND.

Mr. Bishop's Observatory,
Twickenham: 1869, March 16.

THE SUN'S DISTANCE.

Sir,—Unwilling as I am to occupy any part of your valuable space by anything having the appearance of controversy, the letter of P. S. in your number for this month demands a few words from me.

Your correspondent seems to have arrived at *new found land*, and found himself in a fog. He says my letter is no real answer to his question, at least not in the "spirit of the age." Question was, "Why did Mr. Stone, in publishing his re-discussion of the transit of Venus, overlook (designedly or otherwise) the fact that Professor Newcomb had done the work before him?" Answer was, "Professor Newcomb *never discussed the transit of Venus at all.*" If that is not a sufficient answer for the spirit of the age, or of any age, this age must not only be a peculiar one, but your correspondent must know more of past ages than any historian, and more of future ages than any prophet.

Although, then, I had thus sufficiently answered his question, a hint appeared not out of place as to how in all probability his mistake arose.

Professor Newcomb "published his results," P. S. tells us, "a year sooner." In 1867 Newcomb did publish a paper at Washington entitled "Investigation of the Distance of the Sun from the Observations of Mars made during the opposition of 1862 and from other sources." P. S., we must presume, read only the title of the paper and took for granted that the "other sources" included an original discussion of the transit of Venus. Had he referred to § 9, p. 28, he would have learned that instead of this Newcomb accepted, without comment, the result of Powalky's investigation. This was published (or rather re-published) in the "Connaissance des Temps" for 1867, and undoubtedly preceded Mr. Stone's. But no one ever supposed that that gentleman claimed priority over Powalky; and indeed it cannot be stated that he omitted all mention of it, since he gives at the end of his paper (see *Monthly Notices*, vol. xxviii. p. 265) his reasons for not being able to accept Powalky's investigation. His own result was nearly similar, but it was arrived at by a very different process. Powalky so selected and weighed the observations he used as to obtain a result as nearly as possible agreeing with those derived from other sources. Stone, without any forcing or selection whatever, used *all* the observations from which the duration of transit could be determined, and, interpreting them in a way which is really *à priori* the most natural, showed that all gave similar values, very nearly the same as the observations of Mars. Newcomb, as I mentioned in my last letter, at once accepted the latter determination, only expressing doubt on one point. But he neither was, nor pretended to be, aggrieved at the publication as being a false claim to priority over any original investigation of his own, having, as I said, never originally discussed the transit of Venus question at all. No doubt he would be surprised at finding that your correspondent had so unnecessarily taken up the cudgels on his behalf.

Apologising for troubling you at this length,

I remain, your obedient servant,

1869, March 3. W. T. L.

THE SUPPOSED NEW PLANET VULCAN.

Sir,—It may interest a portion of your readers to be informed that the Sun will be continually under observation, when visible, from March 14th until April 14th, with the view of re-discovering the suspected intra-Mercurial planet Vulcan.

There are sixteen gentlemen engaged making observations, nearly all of whom have certain fixed periods in which to carefully watch the solar disc.

There are several powerful telescopes employed; Mr. James Cook of Preston, using a 10-in. Newtonian reflector; Mr. Philip Vallance of Storrington, a 12-in. reflector and a 6-in. refractor; Mr. T. P. Barkas of Newcastle-on-Tyne, a 4¼-in. refractor; Mr. Chas. Hill of Bristol, an 8½-in. reflector; and Mr. Watson of Sunderland, a 5½-in. refractor. The other instruments used are chiefly refractors between 3 and 4¼-ins. aperture.

In some instances two of the observers have been apportioned the same period in which to observe. I have thought this a desirable arrangement, from the fact that, while it may be very cloudy at the situation of one observer, the sky may be perfectly clear at the place of observation of the other.

I am, Sir, truly yours,
WILLIAM F. DENNING.

Ashley Road, Bristol:
March 16, 1869.

Sir,—In that excellent work, *Celestial Objects for Common Telescopes*, by the Rev. T. W. Webb, is to be found a list of sixteen dates when an object resembling a planet has been seen on the Sun's disc.

Is it possible to find out the *synodical* period of the supposed planet by a comparison of these dates? The chief difficulty seems to be that the synodical period is so variable in length. Thus the period between two inferior conjunctions of Mercury during the present year varies from 106 to 123 days. An average synodical period could only therefore be inferred by averaging a great number of revolutions.

The following attempt to solve the question, by assuming an average synodical period of 24 days, may perhaps interest your readers. If we select from the above list those dates only at which the supposed planet appeared round, black, and well defined, and at which it was *actually seen in motion* on the Sun's disc, we have the following eight dates:—

Observer.	Date.	Interval between dates equal to
Schenten . .	June 6, 1761	
		22 periods of 24·13 days
Lichtenberg .	Nov. 19, 1762	
		535 ,, 24·01 ,,
D'Angos . . .	Jan. 18, 1798	
		304 ,, 23·99 ,,
Lofft	Jan. 6, 1818	
		627 ,, 24·01 ,,
Lescarbault . .	Mar. 26, 1859	
		45 ,, 24·22 ,,
Lummis . . .	Mar. 20, 1862	
		29 ,, 23·92 ,,
Beswick . . .	Feb. 12, 1864	
		19 ,, 23·74 ,,
Coumbary . .	May 8, 1865	

The last three of the above are comparatively short intervals, but by averaging the three together we obtain 93 periods of 24·02 days each. The same period of 24 days also agrees closely with the following other dates in Mr. Webb's list.

1764 Beginning of May.
1802 October 10th.
1847 1st half of July (say July 8th).
1857 September 12th.

By calculating in periods of 24 days from the last of the above dates, May 8th, 1865, we obtain the following dates for 1869:—

March 24.
April 17.
May 11.
June 4.
,, 28.
July 22.
August 15.
September 8.
October 2.
,, 26.
November 19.
December 13.

I am, Sir, yours truly,
W. A.

March 3rd, 1869.

THE LATE LUNAR ECLIPSE AND THE TRANSIT OF MERCURY.

Sir,—I have only lately become acquainted with your interesting and useful journal, to which I am now a subscriber.

I see that in the No. for March it is stated (p. 76) that the Lunar Eclipse of January 27, 1869, had not been observed in this country on account of clouds. Permit me to record a fortunate exception.

I got a glimpse of the eclipse shortly after its commencement, and I observed it continuously from the maximum, before which the clouds had broken away again, to the last contact.

There was nothing very remarkable in the eclipse itself. The shadow first touched the Moon near the N.E. point in the second quadrant. At the maximum it *more* than covered Copernicus in the second quadrant and the bright crater Dionysius in the first quadrant. The shadow was of a blackish-brown colour, not so ruddy as it is sometimes observed. The main details of the lunar surface were visible in the telescope through the shadow, and the bright craters were well marked. The penumbra was perceptible.

The shadow left the N.W. edge of the Moon just upon Mare Humboldtianum, which made it very difficult to note the time of last contact; indeed, I failed to do so.

Several times during the decreasing phase of the eclipse a most beautiful iris, more vivid than any I have seen, encircled the Moon.

The eclipse was witnessed by several of the villagers, and one intelligent young man was with me.

Shortly after the eclipse was over clouds re-formed and rain fell.

II. The following is from my notes on the transit of Mercury on November 4th.

I could not see the sun till 8 hr. 10 min. owing to one of our high Cleveland Hills intervening. The sky was bright, and quite free from clouds. The star was much blacker than the sun spots of which there were some fine groups visible. I notice *five* umbræ in my sketch of the largest group, as well as one above and one below the penumbra which enclosed them.

I fancied there might be a very slight trace of yellowish penumbra round the star, but there was much moisture in the air and hoar frost on the ground; besides, it was difficult to disassociate in the mind a large dark spot on the solar disk from penumbra.

As the planet approached close to the Sun's limb at interior contact, it suddenly appeared much drawn out and pear-shaped. I saw this without expecting it. I noted 2′· 25″ from contact of limbs to disappearance at about 8.59 A.M., but owing to the unsteadiness of the Sun's edge it was difficult to determine the exact time of last contact.

My telescope is a small portable equatorial refractor of 2⅝ in. clear aperture; powers used 63 and 120: the power of 200 could not be employed.

A friend of mine with a fine new achromatic of 4¼ in. aperture by Cooke and Sons did not see the elongation of the star.

I am, Sir, truly yours,
RALPH PROWDE.

Ingleby Greenhow Vicarage:
Northallerton, Yorkshire, March 11, 1869.

ROTATION OR NON-ROTATION OF THE MOON.

Sir,—In many recent astronomical works the dogma of the Moon's rotation on its axis is maintained in the old way, and those who disagree with it are held up to ridicule. Mr. Proctor, however, whose careful writings on astronomical matters are well known, says in his "Saturn and its System" with regard to the Moon, "It is a question whether the lunar movements would not be expressed more simply, and (taking dynamical considerations into account), more accurately, by saying that the Moon rotates about an axis near the Earth, and that this axis is subject to such and such motions, than by the mode of expression generally adopted" (note, p. 209). Mr. Proctor, in thus admitting the Moon's rotation on its axis to be scarcely tenable, gives rise to hope that future writers on the subject will use a little consideration before they bind themselves hand and foot to questionable statements.

Very few of those who speak decidedly on the subject know what the "Moon Controversy" really is. This is what is disputed: *that the Moon rotates on her axis in her orbit round the Earth in the same manner as the Earth rotates on its axis in its orbit round the Sun.* Now, some appear to imagine that the actual turning round of the Moon is disputed; no such thing. We all know that the Moon turns round to everything in the heavens except to the Earth. It is necessary, in order to describe the movements of the heavenly bodies consistently, to decide from what stand-point their movements shall be considered. It is generally allowed by astronomical writers that the planets move in elliptical orbits: this is quite true, if their paths are considered in reference to the Sun, but the movement of the Sun in space being admitted, these ellipses are only apparent, and are not the *actual paths* of the planets in space. So with the Moon. Astronomers always describe the orbit of the Moon as an ellipse; so it is, but the path of the Moon is not an ellipse except *with reference to the Earth.* Now it will be at once seen that the Sun being admitted to be in motion, and the direction and amount of this motion being unascertained, nothing can be positively known as to the *actual* paths of the planets and their satellites in space. They are therefore, and properly, described as travelling in their *apparent* paths round their centres of revolution, and their true motion in space is disregarded. How is it then that, in describing their movements in these paths, we are told, under penalty of being considered scientific heretics, that we must speak of their *actual* and not their *apparent* movements? The Moon in its path round the Earth does *not* rotate on its axis; it could not do so without our seeing all round it. The Earth, in its path round the Sun, *does* rotate on its axis; if it did not, it could not present every side to the Sun. Experiments and diagrams seem utterly useless to convince those who enter into this controversy; if the fact, admitted by all, of the Moon turning round to every object outside of her orbit is a proof of her rotation on her axis, we must, if we wish to be consistent, cease to describe the paths of the Moon and planets as ellipses.

Obediently yours,

London, March 1869. P. G. L.

Sir,—One shrinks instinctively from a discussion of the old question whether the Moon turns on her axis or not, as a subject about which it is hopeless to argue; which seems to be, in Lord Dundreary's language, "one of those things which no feller can understand," and which seems to be never mentioned but to call forth opposite opinions. Yet I am tempted to call attention to the simple experiment mentioned below, because it makes clearer to one's mind than any other that I know of the rather complicated movements of the Moon in her double revolution round the Earth and the Sun.

Your correspondent Mr. Perigal does not leave it quite clear whether he wishes to assert that the Moon does go round the Earth, or the Earth round the Moon. But in the former case he says the experiment of the compasses ought to convince anyone "that the Moon does *not* turn on her axis."

I am one of those whose convictions are quite unmoved by it, nor do I think the compasses help to clear the matter much, not near so much, *e.g.* as moving sideways round a stick stuck in the ground, or any like stationary object, so as to keep your face always turned towards it; in doing which it appears to me (though I don't wish to argue the matter) that I am turning slowly on my own axis all the time.

Let us, however, take something that represents more nearly the true course both of the Earth and the Moon as they move onward together.

If, for instance, we take the centre of a carriage wheel in motion to represent the Earth's course, then a point taken anywhere between the centre and the circumference, but nearer to the former, will represent (with sufficient accuracy for our present purpose) that of the Moon.

To show this experimentally, take a circular piece of wood (say, 6 or 8 inches in diameter), and make one hole through the centre and another a little distance from the centre. Put a pencil point through each and roll the piece of wood along a flat surface in such a way that the pencils shall be made to mark their course upon a piece of paper.

The diagram sent shows the result; the straight line representing the course of the Earth, the curved one that of the Moon.

How the Moon can be made to travel this path, always keeping the same side towards the line which represents the Earth's course, *without* turning on her axis, is a problem whose solution is not easy to see. Nevertheless, it is useless to argue the matter with those who think otherwise.

March 5. J. H. J.

[We regret we cannot be at the expense of engraving illustrations to letters on this subject; every possible variety of diagram will be found in our second and third volumes. The Moon controversy appears to be most fascinating; again we have numerous letters on the subject pro and con. Cannot some of our more learned and experienced correspondents settle the matter?—Ed.]

LIST OF SUBSCRIBERS—Names received since our last number.

Abbott, Franz, Esq., Private Observatory, Hobart Town, Tasmania.
Hemming, Rev. B. F., Severn Stoke, near Worcester.
Turnbull, Mungo, Esq., Toronto, Canada.
Warriner, H., Esq., 14 The Grove, Clapham Road, Surrey.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To March 1869.
Metcalf, Rev. W. R.

To June 1869.
Beechey, W. H.
Buffham, T. H.
Howlett, Rev. F.
Lawton, W.
Sargent, Rev. J. P.

To July 1869.
Scott, W.

To September 1869.
Hemming, Rev. B. F.
Williams, J. M.

To October 1869.
Elvins, A.

To December 1869.
Fleming, Rev. D.
Gill, D.
Hedgland, Rev. J.
Hibbert, G.
Lewis, R. T.
Shawcross, W.
Varley, C.

March 20, 1869. Subscriptions after this date in our next.

NOTICES TO CORRESPONDENTS.

Several communications are deferred for want of space.

The *Index and Title-Page for Vol. VI.* are nearly ready, and will be delivered with our next number.

Errata. No. 75, page 70, line 2 (letter on Zeta Cancri), for close *pairs*, read close *pair*; line 10, for *blank* space, read *black* space.

ASTRONOMICAL OCCURRENCES FOR APRIL 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Mars —
Thur	1	5 47	Sidereal Time at Mean Noon, 0 39 31·8 Conjunction of Moon and Saturn, 2° 40′ S.	The Satellites of Jupiter are invisible during April, Jupiter being too near the Sun.		8 34·9
Fri	2		Meridian passage of the Sun, 3m. 34s. after Mean Noon			8 31·2
Sat	3	8 48	☾ Moon's Last Quarter			8 27·6
Sun	4	16 52 18 9	Occultation of σ Capricorni (5½) Reappearance of ditto			8 24·0
Mon	5	16 3	Occultation, reappearance of θ Capricorni (4)			8 20·5
Tues	6					8 17·0
Wed	7					8 13·6
Thur	8					8 10·2
Fri	9	20 13	Conjunction of Moon and Mercury, 1° 24′ N.			8 6·8
Sat	10	19 18	Conjunction of Moon and Venus, 3° 10′ N.			8 3·5
Sun	11	13 47 18 34	● New Moon Conjunction of Moon and Jupiter, 3° 58′ N.			8 0·2
Mon	12					7 56·9
Tues	13					7 53·7
Wed	14		Illuminated portion of disk of Venus, 1·000 of Mars, 0·894			7 50·5
Thur	15	6 54	Near approach of Moon to Aldebaran (1)			7 47·4

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m. Moon
Fri	16	 7 37 8 26 8 26 8 54 18 12	Sidereal Time at Mean Noon, 1 38 40·1 Occultation of 119 Tauri (5½) Reappearance of ditto Occultation of 120 Tauri (6) Reappearance of ditto Conjunction of Jupiter with the Sun			3 37·4
Sat	17	23 40	Conjunction of Moon and Uranus, 2° 56′ N.			4 31·0
Sun	18		Meridian Passage of the Sun, 0m. 44s. before Mean Noon			5 26·2
Mon	19	3 6	☽ Moon's First Quarter			6 22·3
Tues	20	13 10	Conjunction of Moon and Mars, 1° 58′ N.			7 18·4
Wed	21	1 56 2 19	Occultation of Regulus (1½) Reappearance of ditto			8 13·9
Thur	22	10 36 13 25	Near approach of Moon to σ Leonis (4) Conjunction of Jupiter and Venus 0° 7′ S.			9 8·5
Fri	23		Saturn's Ring: Major Axis=40″·5 Minor Axis=18″			10 2·6
Sat	24	6 8 15 3 16 1 15 49 16 32	Conjunction of Jupiter and Mercury, 0° 1′ N. Occultation of 65 Virginis (6) Reappearance of ditto Occultation of 66 Virginis (6) Reappearance of ditto			10 56·3
Sun	25	18 21	○ Full Moon			11 50·2
Mon	26	7 40	Conjunction of Venus and Mercury, 0° 22′ N.			Mars — 7 14·9
Tues	27					7 12·1
Wed	28	13 53	Conjunction of Moon and Saturn, 2° 28′ S.			7 9·3
Thur	29	1 23 12 23	Superior Conjunction of Mercury Occultation, reappearance of B. A. C. 6098 (6)			7 6·6
Fri	30					7 3·9
Sat May	1					7 1·2

THE PLANETS FOR APRIL.

At Transit over the Meridian of Greenwich.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	23 47 17	− 4 4½	5″·6	22 48·2
	20th	1 25 6	+ 7 21½	5″·2	23 26·8
Venus	5th	0 32 3	+ 1 54½	9″·6	23 32·9
	20th	1 40 42	9 12	9″·6	23 42·3
Mars	5th	9 17 10	+ 18 52½	12″·0	8 20·5
	20th	9 27 50	17 29½	10″·5	7 32·2
Saturn	5th	17 4 31	− 21 7½	15″·8	16 6·6
	20th	17 2 40	21 4	16″·2	15 5·8
Uranus	3rd	6 58 39	+ 23 12	4″·0	6 10·2
	19th	6 59 57	23 10	4″·0	5 8·6

OCCULTATIONS OBSERVED AT TEIGNMOUTH.

BY MR. G. J. WALKER.

		Teignmouth mean time.	h	m	s
1869.	Jan. 24.	120 Tauri, Disappearance	8	27	45·9
	26.	*g* Geminorum „	13	8	12·3
	Feb. 19.	γ Tauri „	11	1	15·9
	21.	71 Orionis „	12	17	59·0
	25.	Regulus „	6	22	10·8

Times probably reliable to one or two seconds.

Winnecke's Comet.—I had a close sweep for this object in a fair sky last night. It does not appear to be within reach of Mr. Bishop's 7½-in. refractor.—J. R. Hind, March 6, 1869.

Companion to Aldebaran.—In reply to J., allow me to send an extract from my note-book:—March 4th. 9 p.m. Sky clear, atmosphere moist, definition excellent. Aperture 3½ inches; glimpses of the 5th star in the Trapezium. Aperture reduced to 1¾ inches, the 4 stars easily seen; likewise the 2 Comites to ι Orionis, Comes to Rigel, Comes to Aldebaran. Power 300.—W. J. H. B.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. Gorton, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 77. MAY. 1869.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868–9.
Sixth Meeting, April 9, 1869.
Admiral Manners, *President*, in the Chair.
Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Minutes of the last meeting were read and confirmed.

Thirty-nine presents were announced, and the thanks of the Meeting given to the respective donors. The presents included several books of interest, and a copy of Smyth's *Astronomical Remembrancer* from the Rev. C. Main, of Ireland; two engravings of the Great Nebula in Orion from the Royal Society, and two glass photographs of the eclipse taken at Aden.

The Rev. S. J. Perry was balloted for, and duly elected a Fellow of the Society.

The following papers were read wholly or in part:—

Note on an Aurora Borealis, April 2, 1869: by Mr. Plummer.

It occurred to the author that something might be added to our knowledge of the aurora by spectroscopic investigation, and he accordingly waited for an opportunity of trying the experiment. On the 2nd instant an aurora was visible, and the result of his examination with the spectroscope was that he saw only one bright white or slightly bluish line. There were few or no rays from the arch of auroral light towards the zenith, but sheets or waves of light ran along it. In the brightest part of the arch he found this one line, which appeared to resemble the brightest line seen in the spectrum of the Nebula in Orion. It was hazy, but at times flashed out strongly. To measure its position involved considerable difficulty, but by flashes from a hand lamp the scale of the instrument was illuminated and the position of the line ascertained. It did not coincide with any solar line, but was very near two lines seen in the air spectrum not far from D, but the author did not think it was absolutely identical with either.

It appeared to agree with a line in the spectrum of α Orionis, which is tolerably conspicuous, and one in the same place in the spectrum of Aldebaran; but exact measures will probably be obtained another time, which, however, may be months hence, and Mr. Plummer therefore sent the present communication to record his progress hitherto.

The President observed that, although the observations were not definitive as to the character of the line seen, they were important as being evidence of the great attention paid to spectrum analysis, which was in fact the question of the day.

Mr. Huggins remarked that the paper was the more valuable as being quite original, the author evidently not being aware of what had been done in that direction by others. The same single line had been observed by Struve, in Russia, about April of last year, who found it not only in auroras of which the light was white, but where they were pink also. He had determined its position, which agreed with Mr. Plummer's result, being about halfway between D and *b*. Since then it has been repeatedly seen by Angstrom at Upsala, who has laid it down in the map of atmospheric lines in the atlas prepared by him. This line does not coincide with any terrestrial element, or any of the air lines.

Mr. Airy: Is this included in the normal spectrum of Angstrom?

Mr. Huggins: At the end of the normal spectrum is one of air lines. This is a dotted one in these air lines.

Mr. Airy: Is it distinguished?

Mr. Huggins: Yes; by being dotted. It is the only one which has been certainly seen in the aurora.

Mr. Airy: Although it has been settled by Struve and others that the light is monochromatic, this should not discourage fresh observations, as different results may be obtained in different countries. The aurora is only properly seen in the north; as visible here we do not see the bottom of the aurora, but only the faint uttermost parts of that visible in the north of Europe.

Mr. De la Rue: Of course these lines are caused by some heating or other force in our atmosphere. I presume it is not imagined the aurora is above the atmosphere, and I should like to know whether the line belongs to either oxygen or nitrogen?

Mr. Huggins: It might have been expected that the line would have been found in the spectrum of either oxygen or nitrogen, but it is not so.

Mr. De la Rue: We know that the spectrum of these bodies differs according to the tenuity of the gases. Is the non-coincidence due to this cause or to a new element?

Mr. Huggins: I have found no difference in the spectrum of these gases between the vacuum of a Sprengel's aspirator and a pressure of 20 atmospheres.

Mr. Airy: In a report to the British Association many years ago it appears that Mr. Fisher, who had resided in the Arctic regions, received the impression on his mind that the aurora was formed very low in the atmosphere, and streamed up to the higher regions. It is therefore clear that what was seen at St. Petersburg would be very different to what was visible here. It is like looking at the top and bottom of a flame.

Mr. Huggins: Struve saw only one line, but Angstrom perceived traces of another line.

On the Determination of Longitudes by the Electric Telegraph: by Commander Ashe.

The author, having had some experience in determining longitudes by the above method, thought a record of his proceedings might be useful. Sir W. Logan, head of the Geological Survey in Canada, lately requested Lieutenant Ashe to fix the position of a station at Trois Riviere, about 125 miles from Quebec. He therefore started, taking with him a transit instrument, and set it up at the telegraph station. Generally he mounts the transit on a large stone, but as the ground was covered deep with snow, and no stones procurable, he took a barrel of sand, and placing a board at the top, poured buckets of water over it. As the thermometer was below zero the whole was soon frozen into a solid block, upon which the instrument could be placed. Time and signals were then exchanged with Quebec, and the transit being then turned into the prime vertical, the latitude was obtained. The details and results were given in the paper, both latitude and longitude being got in the first four fine nights. As in England so in Canada, boys were sometimes very troublesome, throwing stones at the light in the hut. The wooden rails of the fences standing out of the snow furnished good meridian marks. The operations took nineteen days, and were completed at a small expense.

The President noticed the energy and promptitude of Commander Ashe, and as to the annoyance caused by boys, said it reminded him of a friend in Mexico who, being in charge of the telegraph between the Emperor Maximilian and the French army, frequently had his wires cut, but put a stop to it by the summary process of hanging some of the offenders.

Mr. De la Rue said he would take advantage of the opportunity to exhibit enlarged paper copies of the Guntoor photographs of the eclipse, more especially as Dr. Edmund Weiss, of Vienna, was present as the representative of the Austrian Aden expedition, and would make some observations afterwards. So far as the astronomical value was concerned these photographs were eminently successful, but as photographs they were not perfect, from crystallisation of the silver salt, and other causes. Mr. De la Rue pointed out the principal details, and said the glass pictures were still more instructive. The Aden and Guntoor pictures agreed well, except that the great horn had a difference of 6° in radial direction, showing a change, although probably not one due to rotation.

Dr. Weiss, who was most warmly received, said that if he ventured to speak a few words in English, he must ask the patience of the meeting for any imperfections. He went to Aden with the Austrian expedition, but there was another sent by the North German Government. This latter expedition took charge of photographing the eclipse, and obtained six pictures, but two of them were imperfect, through clouds. He had only seen the negatives until the two positives exhibited to-night were shown him. The telescope used by the photographers was of six inches aperture, and about seven feet focal length. It was made by Steinheil, and had the visual and actinic foci of the object-glass coincident. It worked very well, the photographs showing all the prominences that appeared in the equatorial. The Austrian expedition comprised three observers. One gentleman was to measure the position, height, and variation of the prominences; Dr. Weiss was to observe the corona; and the third observer to use the spectroscope. Dr. Weiss intended to measure the greatest irregularities of the moon to see whether the principal rays of the corona coincided with them, but this was prevented by clouds until just before the totality. The sun, however, appeared a few minutes before the total eclipse, and from a comparison of the Aden photographs with those of Major Tennant, it appears that the three greatest prominences seen in India were also observed at Aden. One was surrounded by the fine-rayed band of light which, at the beginning and end of an eclipse, shoots from the moon. This prominence was very complicated in structure, more like several interwoven together. Another was the great one, like a finger, 3′ in height. The third was only seen at the end of the totality, and was not exactly like the Indian photograph, being less elongated and more of a cone. The Indian observers seem generally to have seen the same three prominences, but M. Stepan, at Malacca, did not see the first complex one, but another nearer to the great horn. Mr. Lockyer and M. Janssen have shown that rapid changes take place in those objects, and two hours' difference may therefore well make changes. The great horn altered slightly between Aden and Guntoor. The sky was very cloudy, and sadly interrupted our observations. The corona had two large beams of light of considerable width near the principal prominences. The beams were somewhat of a parabola in shape. Lastly, as to the spectroscope. It being known that the English expedition would attend to the prominences, the Austrian observer determined to pay the greatest attention to the spectrum of the corona, and he reports that at the moment when the last spark of the sun's light disappeared the dark lined spectrum became continuous, like that of ignited metals. It was pale but perfectly distinct, and was decidedly a continuous spectrum. In conclusion, the speaker said the English Government received the expedition with the greatest kindness, and gave them every assistance. Indeed, without such help it would have been impossible to obtain the results they did.

The President, in the name of the meeting, thanked Dr. Weiss for his very clear and lucid exposition, and assured him he had nothing to fear for his excellent English.

Mr. De la Rue wished to call particular attention to the statement that the spectrum of the corona became continuous, which was a perfectly new observation to him.

Mr. Lockyer said he must confess that when he saw in Major Tennant's report that the spectrum of the corona was continuous* he thought it must be a printer's error, but finding it now confirmed, the subject became more difficult than ever. He would also make a few observations on the statements as to the prominences. The first finger-shaped one appeared to have changed its direction with regard to a radial line, and the other one altered its form and settled down to that of a cone. These changes were similar to some seen by the speaker on March 14. Early in the morning of that day he saw a fine dense prominence about 30,000 miles high. In two hours it had entirely changed its form. The dense appearance was gone, and very much detail became visible. It was then a perfectly straight brush, as straight as if ruled. After an absence of ten minutes he found it had utterly disappeared, but whether it was extinguished or merged in another prominence he could not say. The whole chromosphere was in a sort of wavy motion, and higher in the morning than afterwards. It is a common thing for the prominences, as the projectile force becomes less intense, to fall down into the chromosphere. His observations on this day showed that an injection of sodium and barium as well as hydrogen was taking place from the photosphere into the chromosphere, causing the dense prominence.

Mr. Huggins: Dr. Weiss's remarks are of extreme interest, especially as to the continuous spectrum of the corona. The Indian spectrum of the corona was stated to be continuous, but this was understood to mean that it did not differ materially from the usual spectrum of the sun's light reflected, in contradistinction to one of bright lines. The polarisation experiments show that the corona is reflected light, but Dr. Weiss says that Fraunhofer's lines are absent in its spectrum. But for the polarisation in a plane passing through the sun's centre the corona might consist of small white hot particles, which would give a continuous spectrum, free from dark lines, but these things are difficult to reconcile. Was the spectrum pretty bright? Because otherwise the lines might not have been seen simply from the feebleness of the whole spectrum.

---

* Vide *Astronomical Register*, vol. vii. p. 37.

Dr. Weiss: As I learn from the observer the corona spectrum was pale, but not so pale as to make him think he could not see the Fraunhofer lines simply on that account. He subsequently opened the slit wider without producing any alteration, excepting the spectrum becoming badly defined. It is very difficult to understand this result; but I imagine the corona may consist of two parts—the one reflected light which accounts for the polarisation, and the other due to self-luminous gas round the sun. Then may not the bright lines of the latter replace the Fraunhofer lines of the former and thus produce a continuous spectrum?

Mr. Huggins: It might be possible, if the bright lines were exactly of the right character. With respect to the supposition of self-luminous gas, it is difficult to conceive any gases extending beyond the hydrogen, which forms the prominences. Hydrogen must be the extreme boundary of these gases. To account for the continuous spectrum, the corona must be a ring of detached particles.

Dr. Weiss: I can only say, that is the observation. When the slit was opened nothing more was seen. The spectrum did not become so faint as to cause the lines to disappear.

Mr. Huggins: To see the lines a very narrow opening is required. A very little wider and they would be put out.

Dr. Weiss: The slit was sufficiently narrow at first.

Mr. Lockyer: Dr. Frankland and I think that the corona is not a solar appendage at all, and M. Faye has also been driven to this supposition. If the memoirs of this Society be referred to, it will be found that in 1851 the accounts of the eclipse by Messrs. Airy, Carrington, Hind, Lassell, and others are so different as to show that the appearances depend on the observer or the locality, and this suggested to M. Faye that the corona is an atmospheric phenomenon.

Mr. Airy: I have seen the corona in three total eclipses, and am also familiar with the spectral lines, and I must say I attach no importance to these lines not being seen on the corona spectrum. On the contrary, I should have been much surprised if they had. I entirely agree with Mr. Lockyer in his view of the corona, and from my observations in Spain cannot conceive it is anything so distant as the moon. It appears to me something so near as to be materially affected by the locality of the observer.

Mr. De la Rue: A distinction must be drawn between the soft light extending a long way off the sun and the ring of light close to its body. The latter must be appertaining to the sun, and is proved by the photographic evidence. The more distant light may be of a different nature, and the polariscope observations may apply to these distant rays, but the corona proper is a solar phenomenon.

Mr. Airy: What is the extent of the ring you refer to?

Mr. De la Rue: About 3 minutes of arc.

Mr. Huggins: Is that the part observed as stated by Dr. Weiss?

Dr. Weiss: Yes, the part quite close to the sun.

Mr. De la Rue: In the photographs the corona is indicated as extending from 3′ to 5′ beyond the limb of the moon.

Mr. Lockyer: The appearance of the photographs does not prove that this light belongs to the sun. If it were strong enough, although placed side by side, it would photograph itself, and if there why should it not give a spectrum as easily as the hydrogen does. We might expect to find many substances in this region, but except those I have mentioned as being injected into the chromosphere, we find nothing but hydrogen. I would ask Mr. De la Rue whether these would not show in the photographs?

Mr. De la Rue: I would point out that the moon does not shut out the atmosphere, but slides over the sun.

Capt. Noble said that, looking at the Aden photographs, the finger-like prominence appeared to be projected on to the body of the moon.

Mr. De la Rue explained that this was the extent of the prominence at the first moment of impact of light, and that during the exposure the moon advanced to the outline shown, but did not obliterate the first impression of the prominence.

Capt. Noble thought this rendered the photographs unreliable for exact measurement.

On some effects of the Comparative Clinging of the Limb of Venus to that of the Sun in the Transit of 1784, *compared with that of* 1882: by Mr. Stone.

As M. Puiseaux and Mr. Proctor advocate the observation in 1874 of the difference of absolute duration of the transit at north and south stations, it becomes important to consider the much slower motion of Venus at the places of observation in this transit than in 1882. This will cause much more difficulty in observing the same phase of the transit, the times differing as 29 minutes are to 20 minutes, and the probable error of observation being increased in proportion from the much slower motion of the planet across the limb of the sun. The altitude of the sun will also be low at some stations, and the observations of 1769 at 5° of altitude show that nothing less than 10° should be used.

The President: This is an important paper, and tends to show the value of the remarks made by Admiral Ommaney and Sir E. Belcher at one of our meetings, not that a preliminary expedition should go out, but that the observers should, if possible, have several months' practice at their posts, in observations as nearly like what they will have to do at the transit as can be devised.

The Astronomer-Royal: I do not think it possible to make any experimental imitation of the transit of Venus. The expected appearances must be well studied beforehand, and the observations made as well as they can when the moment arrives, but experiments in refraction and irradiation may be made as well in England as at the observing stations. With respect to the importance of training, I would refer to the Maine boundary. It was required to cut a line for 65 miles through a dense forest and an almost impassable swamp, and the question being referred to me, I saw no way to do it but to determine geodetically and astronomically the latitude and longitude of the extremities, and compute the direction of a telescope to cut through the woods. This was carried out successfully, and the two parties met, I believe, within 200 yards of each other. Now, it is important to know that the training for this operation was principally carried on with a carpenter's bench in the grounds of the Royal Observatory, and that the latitude and longitude of the centre of this bench were determined many times by the officers of the party. Similar work may therefore be better done there or in some similar place than at a distance. There is no difficulty in the training; but for the nervous part, when the observer finds himself in presence of a new phenomenon, nothing but reading can be used as a preparation.

Mr. Penrose: Might not some advantage be derived from observing a bead or disc sliding on a wire in the eye-piece before the sun?

Mr. Airy: I won't say it is not worth trying.

Mr. Huggins: I tried this experiment with respect to the bright spot seen on Mercury at its transit, and used a small disc to correspond with the planet on the sun's disc, but saw neither the white spot nor the aureola.

Mr. Penrose: Did you see any ligament?

Mr. Huggins: I did not move the disc across the limb.

Mr. Stone: If the ligament be produced, as I expect, it will not be seen at all in any such experiment. In transits one person says he saw contact at a certain time, and another person at the same station 20 seconds after sees another. I say this is not the same phenomenon, and the observations are not to be mixed up together, or we shall get in a mess as we did before The image of a star would give a bright point in the centre, and the light degrades rapidly from this. So with a black disc the undulatory theory accounts for a bright centre and rapid degradation beyond.

Capt. Noble: I am not so sure that you would not see the ligament with artificial apparatus. When the thumb and finger are approached in front of a strong light, a ligament is easily seen.

Mr. Browning explained a method of producing such an effect by placing a moderator lamp on a table near a folding-door, one-half being open and the other closed; then, by sliding a half-crown across the edge of the door, the ligament was produced with certainty. He had tried all sorts of ways to produce the white spot which Mr. Pritchard said was due to interference and was a result of the undulatory theory, but without success.

Mr. Huggins: I do not think the spot is due to this cause. It was not on the centre of the disc, and was too large.

Description of an Improved Driving Clock: by Mr. Kincaid.

Having had some experience with driving clocks, the author came to the conclusion that as now constructed they will not do for large telescopes, and are not good enough for spectroscopic observations at all. He therefore devised a form in which the regulation is effected by a liquid running off by a syphon, in proportion to the centrifugal force. He exhibited a diagram, but had not made the machine, and not being likely to do so for some time, offered the plan to the Society at once. He had intended to use castor oil for the fluid, but Mr. Huggins had suggested glycerine as preferable.

On the Problem of the Determination of a Planet's Orbit, from three Observations: by Mr. Cayley.

Professor Cayley gave an oral explanation, and drew diagrams of the method propounded by Gauss.

On the Practical Speed of Electricity through 7200 *Miles of Land-wire*: by Mr. Davidson.

On the Transit of Mercury in November 1868: by Mr. Row.

On Personality in Observing Transits of the Limb of the Moon: by Mr. Dunkin.

One result of the extreme accuracy of modern observations is seen in the notice taken of personality in observations by different persons. This has long been known to exist, and in some cases to amount to 1s. in transits. Mr. Sheepshanks also found it among the persons who made micrometer measures for the standard yard. It has also been noticed in reading circles, and at our last meeting Mr. Stone read a paper on the personality in the observations for collimation. In 1848, upon the erection of the altazimuth, the Astronomer-Royal found a large personality between Mr. Breen and Mr. Dunkin himself, amounting nearly to half a second of time. In examining this question the author has taken the observations since 1863, when Hansen's tables were brought into use, and 1868, during which time the observers have been Mr. Ellis, Mr. Dunkin, Mr. Criswick, and Mr. Carpenter, and the instruments used the altazimuth and transit circle. Very elaborate tables are given in the paper of the differences found among the observers, the result being that there can be no doubt there is a real personal difference in observing an approach to a wire. There may be a difference between seeing the moon move towards a wire and on the leaving it. The observers may differ in the one case and not in the other, and the most curious part of the result is that the personality shows itself principally in producing errors at the first limb of the moon, and very little at the second limb. The differences may be explained by supposing that each observer sees a different semi-diameter, and as a mean semi-diameter is used at the Observatory, the differences come out in the tables. With the transit circle observations the differences are much smaller, and would hardly be noticed if this instrument were alone used. The tables also show the advantage of intermixture of the observers. A set of observations by one may appear quite in accord, but are all affected by one error, while if well intermixed the errors of the different observers compensate one another, and the mean result is probably nearly free from error.

The President: Such an investigation as this can only be properly applied to the observations at a first-class observatory, and when we find a gentleman busily engaged in his regular labours doing such extra work as this, he deserves double thanks.

Mr. Stone narrated several instances in which the value of such investigations had become apparent, connected with his own researches. One was in working out the longitude of Sydney, from observations there by Mr. Scott; another was in getting the lunar parallax by observations at Greenwich and the Cape; and the third in obtaining the solar parallax from the parallactic inequality of the moon. In all of these cases he found the observers did not observe the moon's limb in the same way; in fact, each had his own semi-diameter.

The meeting then adjourned.

Errata in last Report.—Page 80, line 25, for Poiseau read *Puiseux*. In page 86, the statement that *the prisms are removed* in Mr. Huggins' second method of viewing the solar prominences *is incorrect*.

THE TOTAL SOLAR ECLIPSE OF AUGUST 1868.

In consequence of the great importance of the discovery of the gaseous nature of the Prominences made at this Eclipse, and of the still more extraordinary independent discovery by M. Janssen and Mr. Lockyer of the method of perceiving the protuberances without an eclipse, we are induced to offer our readers a translation of the Reports of M. Janssen and M. Rayet to the French Government, printed in their own language in the Annual Report of the Royal Astronomical Society.

Report of M. Janssen.

PART I.

The Messageries Impériales steamer which conveyed me from France landed me on July 16th at Madras, on the Coromandel coast. Here I was received by the English authorities with the greatest courtesy. Lord Napier, Governor of the Province of Madras, had me conveyed to Masulipatam in a government steamboat. Mr. Graham, a collector in the neighbourhood, was attached to my mission, to smooth any difficulties I might encounter in the interior. It remained for me to choose my station. If we cast our eyes over a map of the eclipse, we see that the line of centrality, after having crossed the Gulf of Bengal, strikes the east coast of India at Masulipatam. It cuts the mouths of the Kistna, crosses the great plains formed by the delta of this river, and afterwards runs through a mountainous country, containing several chains, situated on the frontier of the independent State of the Nizam.

Upon discussing the whole of the very extensive information obtained, I was led to choose the town of Guntoor, situated on the central line of the eclipse, at an equal distance from the mountains and the sea. I thus avoided the sea fogs, so very frequent at Masulipatam, and the clouds which often crown the elevated peaks.

Guntoor is an Indian town of much importance, the centre of a large trade in cotton. The greater part of this cotton comes from the States of the Nizam, and is sent to Europe by the ports of Cocanada and Masulipatam. The families of several French merchants reside at Guntoor; they are descended for the most part from the ancient and numerous families who, in the past century, made our beautiful colonies of India flourish. My observatory was set up at the house of M. Jules Lafaucheur, who kindly placed at my disposal all the first floor of his house, the highest and best situated in Guntoor. Portions of this first floor communicate with a large terrace upon which I had erected a temporary building, answering the purpose of our observations.

My instruments consisted of several large telescopes of 6 inches aperture, and a Foucault telescope of 21 centimetres in diameter.*

The telescopes were mounted on an even platform, which made them steady. Motion was communicated by mechanism, constructed by MM. Brunner Brothers, which allowed of the sun being followed by a very simple movement. The instruments were supplied with finders of 2 and 2¾ inches aperture, being themselves good astronomical telescopes.

In spectrum analysis of the heavenly bodies, the finders are of great importance. It is by their aid that we know upon what exact point of the celestial body under observation the slit of the spectroscope attached to the principal telescope is placed. It is then of the greatest consequence that any object of importance, situated in the field of the finder, when placed upon the cross wires, should be brought rigorously on the slit of the spectroscope. All my care was directed to attain this indispensable result. Special micrometers were also provided, to measure rapidly the heights and angles of position of the protuberances. As to the spectroscopes adapted to the large telescopes, I chose them of different optical powers, calculated for various requirements of the phenomena of the eclipse. In addition, all the instruments* carried at the eye-pieces screens of black cloth, making a dark room, and designed to preserve the sight in its fullest sensibility.

---

* The mirror of this telescope had been parabolised by M. Martin, who kindly gave his disinterested assistance to our expedition.

Independently of these instruments devoted to the principal observations, I had brought a rich collection of thermometers of great sensibility, constructed with all the skill of M. Baudin,† portable telescopes, hygrometers, barometers, &c. I also made use of the kind assistance of MM. Jules, Arthur, and Guillaume Lefaucheur, who placed themselves at my disposal for secondary observations.

M. Jules Lefaucheur, a practised draughtsman, took charge of the drawing of the eclipse. An excellent telescope of 3 inches, supplied with cross wires, was entrusted to him, with which he made experiments beforehand, on artificial representations of eclipses, so as to be able to reproduce, in a quick and certain manner, the phenomena which he would have to depict. The observation of the temperatures was confided to M. Arthur Lefaucheur, who was also at the moment of totality to ascertain, by a very simple photometric experiment, the luminous power of the protuberances and of the corona.

I was assisted in my own observations by M. Rédier, a young aspirant to the rank of officer, whom the commander of the steamboat *L'Impératrice* had been kind enough to place at my disposal. The assistance of M. Rédier, who was endowed with a natural aptitude for scientific observations, was very useful to me.

The time which remained to us before the eclipse was employed in preliminary practice with the apparatus; this had the advantage of making all familiar with the management of the instruments, and gave me the opportunity of making many improvements in their detail.

The eclipse drew near, and the weather did not appear likely to favour us. It rained for many days all along the coast: these rains were considered as exceptional. Very fortunately the weather improved by degrees before the 18th. On the day of the eclipse, the sun shone at rising, although still in a bed of mist; he soon emerged from it, and at the moment when our telescopes gave us notice of the commencement of the eclipse, he shone out in all his brilliancy.

Each one was at his post. The observations began immediately. During the first phases some light mists passed over the sun; they marred the nicety of the thermometrical measures, but when the moment of totality approached the heavens became again sufficiently clear.

By this time the light had visibly diminished: objects appeared as if lighted by the moon. The decisive moment drew near, and we waited for it with great anxiety. This, however, did not affect our intellectual powers: they were rather over-excited, and this feeling was amply justified by the grandeur of the phenomena nature had prepared for us, and by the knowledge that the fruits of our great preparations and a long voyage depended entirely upon the observation of some moments' duration.

---

* MM. Bardon and Secretan kindly lent me two of the four object-glasses I had with me; M. Bardon also provided me with the greater part of my apparatus. It is due also to M. Wentzel that I should acknowledge the excellence of my prisms, which was daily manifested.

† Among these thermometers was one constructed, at my suggestion, by M. Baudin, on the plan of the differential thermometer of M. Walferdin, but of which the bulb was not more than 1 millimeter in diameter.

Soon the solar disc was reduced to a thin luminous crescent. We redoubled our care and attention. The slit of the spectroscope on the 6-inch telescope was kept rigorously in contact with that part of the moon's limb which would extinguish the last solar rays; so that the slit would be brought by the passage of the moon herself into the lowest regions of the solar atmosphere, and become tangential at the instant of the two discs overlapping.

The darkness of totality took place suddenly, and the phenomena seen in the spectroscope changed immediately in a very remarkable manner.

Two spectra, composed of five or six very bright lines, red, yellow, green, blue, and violet, were seen in the field of the apparatus, and replaced the prismatic solar image which had just disappeared. These spectra, about one minute high, corresponded line for line: they were divided by a dark space, in which I could not distinguish any sensible bright line. The finder showed that these two spectra were produced by two magnificent protuberances—one to the right, and the other on the left of the line of the contacts—which had just been the point of extinction of the sun. One of these, especially that on the left hand, was more than three minutes high; it resembled the flame of a forge fire, driven out with violence through the openings in the coals by a strong blast. The protuberance on the right (western side) presented the appearance of a mass of snowy mountains, with the base resting on the limb of the moon, and lighted by a setting sun. These appearances have been excellently drawn by M. Jules Lefaucheur; and I will only remark, before leaving the subject of the protuberances, to which I shall have specially to return, that the observations already described show at once:—

1st. The gaseous nature of the protuberances (bright spectral lines).

2nd. The general similarity of their chemical composition (the spectra corresponding line for line).

3rd. Their chemical constitution (the red and blue lines of their spectra being no other than the lines C and F of the solar spectrum, characteristic, as we know, of hydrogen gas).

I now return to the dark space which divided the two protuberances in the spectroscope. It should be remembered that at the moment of total obscurity the slit formed a tangent to the two discs of the sun and moon, and crossed the circumsolar regions directly in contact with the photospheric regions where the theory of M. Kirchhoff places an atmosphere of vapours which produce, by elective absorption, the dark lines of the solar spectrum. This atmosphere of vapours, when it shines with its own light, according to the same theory, ought to give the solar spectrum reversed; that is to say, consisting only of bright lines. This was the phenomenon that we expected, or at least that we sought to verify; and it was to render this verification decisive that I had taken such great precautions. But now we see that the protuberances alone gave positive spectra or bright lines. Thus it is pretty certain that if an atmosphere of vapours of all the bodies which have been recognised in the sun really existed around the photosphere, it should give a spectrum at least as bright as that of the protuberances formed of gas much more rarefied, and therefore less luminous. It must then be admitted, either that this atmosphere does not exist, or that its height is so trifling that it has escaped observation.

I ought to say, by the way, that this result but little surprised me. My researches on the solar spectrum had led me to doubt the reality of any considerable atmosphere around the sun. And I am more and more induced to admit that the phenomena of elective absorption attributed by the great physicist of Heidelberg to an external atmosphere of the sun really takes place in the photosphere itself; in the vapours where float the solid and liquid particles of the photospheric clouds.

This hypothesis would not only be in harmony with the beautiful theory of the constitution of the photosphere which we owe to M. Faye, but it seems even a necessary consequence of it.

To sum up, it appears true that the eclipse of August 18th has shewn that the constitution of the solar spectrum is not sufficiently explained by the theory admitted to the present time; and it is in the sense thus indicated that I propose to review it.

(*To be continued.*)

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

THE TRANSIT OF VENUS IN 1874.

Sir,—In a paper of mine in the last number of the *Monthly Notices*, there occur two rather important errata, which escaped my notice, on account of the MS. not having been sent me with the proof. As I have since recalculated all the values given in that paper, and as I think the conclusions to which the paper points are not without importance, perhaps you will be good enough to find space for the following statement.

My calculations affect the four places at which (i.), the ingress is most accelerated; (ii.), the ingress is most retarded; (iii.), egress is most accelerated, and (iv.), egress is most retarded. It is to the neighbourhood of these places that the Astronomer-Royal wishes that observers should proceed, in order to take the epochs of the above-named phenomena, so that the sun's distance may be determined by the method of absolute longitudes. To the places themselves it would be useless to go, as the sun would be on the horizon at the epoch of the corresponding phenomenon. But observers must be near these places, otherwise the full amount of acceleration or retardation would not be approximated to.

Mr. Airy has calculated the four places with reference to the passage of Venus's centre across the sun's limb, assuming (which is not strictly correct) that the position-angle corresponding to this phase is identical with the position-angle for external contact. I have calculated the four places with reference to internal contacts, with the corresponding position-angles. My reason for selecting this phase is simply, that it is the only phase ever timed with reference to the calculation of the sun's distance. The following table exhibits the latitudes and longitudes of the places corresponding to the phenomena (i.), (ii.), (iii.), and (iv.), according to my mode and Mr. Airy's respectively:—

		I place				Mr. Airy places	
		Lat.	Long.			Lat.	Long.
(i.)	in	39° 45 N.	143° 23′ W.	(i.)	in	37° 13 N.	138° 38′ W.
(ii.)	„	44 27 S.	26 27 E.	(ii.)	„	37 13 S.	41 22 E.
(iii.)	„	64 47 S.	114 37 W.	(iii.)	„	60 1 S.	136 11 W.
(iv.)	„	62 5 N.	48 22 E.	(iv.)	„	60 1 N.	43 49 E.

I find by the method of mid-latitudes that the distances separating the four places determined by me from those determined by Mr. Airy, are—

For	(i.)	314·0 miles.
„	(ii.)	920·2 „
„	(iii.)	764·5 „
„	(iv.)	208·7 „

Discrepancies so large seem not wholly unworthy of notice. For the transit of 1882, I find discrepancies less considerable, but still large.

I am, Sir, yours faithfully,
South Kensington. RICHARD A. PROCTOR, B.A., F.R.A.S.

PEAR-SHAPED ELONGATION.

Sir,—The appearance, known by this description—which is generally observed when an inferior planet, in transit, approaches internal contact with the sun's limb—may have its origin in atmospheric causes, or in the optical means employed. The following little experiment, which is within the reach of all, rather confirms the latter view:—

Let the extended hand of the observer be placed before his eyes (open of course), at a distance of 4 or 5 inches from the face; being about half the usual focal length, for close observation, of ordinary eyesight. If two contiguous fingers be now caused gradually to approach, and the line of sight be directed to the interstice, then, as soon as a close proximity is attained, the visible edge of one finger will appear, at one or more points, to start forward as if to meet the corresponding edge of the other finger; although the sense of touch declares that no actual contact has occurred.

The illusion is more perceptible when all the fingers are in contact with their neighbours, except the two whose approach is to be scrutinised.

Yours truly,
April 11, 1869, ARCITINENS.

THE SOLAR ECLIPSE OF 1598.

Sir,—In the last number of the *Register*, for the month of April, there is a very interesting communication from Mr. Hind on the past and future of solar eclipses.—During last summer I prepared a short paper relative to the total solar eclipse of 25th February (old style) 1598; which was communicated to the Literary and Philosophical Society of St. Andrews, in November last. By my calculations it would seem that the lunar shadow passed over Great Britain and Ireland, in the form of an eccentric ellipse, whose greatest diameter was sixty-two miles, and the lesser diameter twenty-six miles. In England, the southern limit of totality extended from Dalton in Lancashire on the west, to Hartlepool on the east; and in Scotland, the northern limit of totality extended from Whitehorn in Galloway, to about sixteen miles north-east of Langholme, in Dumfriesshire; when it crossed the border, and entered England. The line of central eclipse extended from Whitehaven to Morpeth. The duration of total eclipse at any place did not exceed more than *fourteen seconds* of time, in consequence of the apparent diameters of the sun and moon being so nearly equal.

Having access to no calculations regarding the eclipse except those of my own, and bringing out the results mentioned above, I am anxious to have my results confirmed, or the contrary, should they be erroneous, by some of your numerous correspondents who are engaged in astronomical calculations.

The eclipse was a very remarkable one, and was well observed, especially in Scotland; and produced a great sensation in the minds of the people and was long remembered by the name of *Black Saturday*. The eclipse of 1652, known by the Scottish people as *Mirk Monday*, was a return of the same eclipse after an interval of three Chaldean periods. The famous eclipse of the 18th August, last year, was a return of the same eclipse.

I am, Sir, yours truly,

Arbroath: April 12, 1869. ALEX. BROWN.

THE SATELLITES OF JUPITER: ARE THEY VISIBLE TO THE NAKED EYE?

Sir,—If your correspondent Mr. Buffham, whose letter appears in your number of the current month, instead of plunging into the metaphysics of vision (into which it would be unprofitable to follow him) had been content to give a plain answer to a plain question, he might have done something to vindicate his claim to the honour of having seen the Satellites of Jupiter by the unaided power of his eyes.

He has stated that "he has *often* seen the third Satellite with the unassisted eye, and that if it be distant a few diameters from the planet he can *generally* see it."

He is possessed, therefore, of a certain definite optical power, of which we have a tolerably approximate gauge; a power which any one may acquire by the help of an opera-glass magnifying five times, the aperture of which may be reduced until the Satellites are on the point of disappearing, or even until they actually disappear.

Let us now suppose two persons thus endowed with the same powers of vision; whatever is seen by the one will be equally well seen by the other; whether the object be a point of light, a church clock, or a page of the *Nautical Almanac*, seen of course from the same point of view.

It must be remembered that when at its greatest elongation the third Satellite is separated from the planet by a space which subtends only the *fifth part* of a degree! The Satellite therefore, when *unmagnified*, is not only enveloped, but must be comparatively drowned, in the radiation of the primary.

But we are told by Mr. B. that the seeing of the Satellites "is a matter of method;" and we must therefore describe "the method" to which he ascribes his success.

He says, "my own plan usually has been to look between the fingers of one or both hands, shifting them so as just to cut off the rays preceding and following, in which position the Satellites always lie."

There does not appear to be anything in this method at all likely to help an observer; and, as it ignores *diffraction*, and the evil effects of currents of heated air, it is not to be commended.

The question which I asked, and which I now repeat is, can Mr. Buffham, or any one else, read the figures of the *Nautical Almanac* at the distance of fifteen feet? If he cannot, I venture to think that he does not possess the requisite power of vision to see the Satellites of Jupiter without a telescope.

I am, Sir, &c.,

Clapham: March 9, 1869. C.

THE SUPPOSED NEW PLANET VULCAN.

Sir,—The sun was carefully watched on favourable occasions throughout the period from March 14 to April 14 inclusive, but no planetary body has been observed in transit. The weather, on the whole, was very unfavourable. In consequence of the cloudy state of the atmosphere, two days, namely, March 15 and April 7, passed without a single observation being recorded.

The solar spots have been very small and scarce, if we except one large cluster, which became visible on the 12th of March, and remained in sight until the 25th. It reappeared on the morning of the 8th of April, and is now not far from the centre of the sun's disc. On the 21st of March this cluster extended over 60,000 miles from east to west, while the diameter of the nucleus of the largest spot equalled 11,000 miles. On the 14th of April the same group covered 59,400 miles from east to west, and 31,300 from north to south. It was, therefore, not much inferior in magnitude to the enormous cluster seen by Mr. John Browning and others on the 7th of March. The largest number of spots were visible on the 19th of March, when 23 were reckoned on various parts of the disc. Many rapid changes in their form and position were noticed to have taken place. On several occasions small spots became visible in the course of a few hours, while others had disappeared with equal rapidity.

I am, Sir, yours truly,

Ashley-road, Bristol: WILLIAM F. DENNING.
April 16, 1869.

Sir,—In order to show how necessary it is to be careful not to rely too confidently upon the value of a planet's synodical period determined by the method adopted by your correspondent "W. A." in this month's number of the *Register*, I trust you will permit me to point out that the observations of the supposed planet Vulcan, referred to by him, may be quite as well represented by using an assumed period of 28 days as by one of 24, which he has used, as will be seen from the following results:—

Date.	Interval between dates equal to
June 6, 1761	
	19 periods of 27·94 days.
Nov. 19, 1762	
	460 ,, 27·92 ,,
Jan. 18, 1798	
	261 ,, 27·93 ,,
Jan. 6, 1818	
	539 ,, 27·92 ,,
Mar. 26, 1859	
	39 ,, 27·94 ,,
Mar. 20, 1862	
	25 ,, 27·76 ,,
Feb. 12, 1864	
	16 ,, 28·18 ,,
May 8, 1865	

By averaging the last three intervals, as "W. A." has done, we have 80 periods of 27·93 days each. The exact period which best represents all the observations is 27·929 days; and, although it may well be doubted whether all the observations cited by "W. A." refer to one and the same object, it is very probable that if the existence of an intra-mercurial planet should hereafter be established, its synodical period will be found to be nearer to 28 than 24 days.

The mean epoch of the observations is Nov. 26, 1823, and using a mean period of 27·929 days, the approximate dates of inferior conjunction, for the remainder of the present year, are :—

May 26
June 23
July 21
Aug. 18
Sept. 15
Oct. 13
Nov. 9
Dec. 7.

I am, Sir, yours truly,
JOSEPH BAXENDELL.

Cheetham-hill, Manchester :
April 12, 1869.

Sir,—Having been a good deal scoffed at by various friends for my sanguine views concerning the intra-mercurial planet, I read with much satisfaction the letter in the April *Register*, and I still have great faith in the reality of the planet's existence. Will "W. A." kindly point out what observations he alludes to under the names of "Beswick" and "Coumbary?" They seem to be some that have escaped my notice, and I am anxious in the matter. Mr. Webb, I see, mentions these, but he gives few particulars, and no references—a serious systematic defect in my friend's otherwise delightful volume. The interval calculations supplied by "W. A." are in my opinion worthy of considerable attention. Spread over more than a century, and in exceedingly unequal batches, there is a consistency which hardly looks fortuitous.

Yours obediently,
G. F. CHAMBERS.

April 3, 1869.

THE LUNAR ECLIPSE IN JANUARY.

Sir,—The phases of the Earth's shadow on the Moon's disc during the eclipse on the 28th January were well observed from this place. I beg leave to send you the following notices of the angles on the Moon's limb at six stages of the eclipse; the time is our mean time on this meridian, which is 1h. 56m. east of Greenwich.

3·0 A.M. . .	N. 82° W. to N. 42°·30 E.
3·15 . .	N. 86° W. to N. 56° E.
3·38 . .	N. 75° W. to N. 74° E.
3·45 . .	N. 61° W. to N. 71° E.
4·10 . .	N. 10° W. to N. 84° E.
4·30 . .	N. 11° E. to N. 71°·15 E.

The maximum of the eclipse was at 3h. 38m. a.m. (civil time).

The Earth's shadow then covered the half of Kepler, extended to Pythagoras, crossed Mare Tranquillitatis, and enveloped Mare Crisium.

All the prominent features of the Moon's surface under the shadow were quite distinct through a Dollond's telescope of 2⅞-in. aperture, and a 5-foot Newton of 4½-in.

Throughout these phases there was a strong red hue on the eclipsed limb of the Moon, ever varying with the arc of the shadow, but always in a radial line from the apsis of the shadow; in other words, as the apsis changed, the extreme redness was always in a radial line with it and the centre of the shadow.

I have already sent you a notice of the leading features of the eclipse extracted from the *Levant Herald*.

Yours faithfully,
CHARLES B. GRIBBLE.

Constantinople:
February 26, 1869.

THE MOON'S ROTATION.

Sir,—There is one very important fact that those who think the Moon does not rotate on its axis take no account of, and appear to be ignorant of, namely, that the Moon has libration; *i.e.* it does *not* turn always exactly the same side to the Earth. This is because it rotates on its axis at a uniform rate, but revolves round the Earth at a varying rate; its orbit also is not round, but elliptical; likewise its axis is not at right angles to its orbit, but is inclined to it, so that while maintaining a fixed direction with regard to space,* when it is on one side of the Earth we see the north pole, and when on the other side the south pole. I do not know how these circumstances could be described without allowing that the Moon rotates; for if it does not, it can have no axis, and therefore no poles. It would be quite as difficult to describe the motions of the Moon without saying that it rotates, as it was for Ptolemy to explain the motions of the planets on the supposition that the Earth was the centre round which they revolve.

Yours truly,
T. W. BACKHOUSE.

13th March 1869.

THE MOON A HABITABLE GLOBE.—On February 1st Mr. John Watson, F.R.A.S., of Seaham, delivered a lecture in Brougham-street Chapel on Astronomy, Mr. Robert Brown in the chair. The lecture was well illustrated by diagrams, the gyroscope, the spectroscope, &c., and the lecturer imparted to his audience the latest discoveries of astronomical science. At the close he referred to the theory he advanced at Seaham, that the moon was a habitable globe. Hitherto he said it had been held that the moon, unlike most of the other planets in the solar system, was not possessed of air or water. He referred particularly to Mars, where the seas were not only visible, but were named, and where ice and snow could be seen as in our polar regions. The moon, however, had been held to be an exception in this respect to all other planets. They could only see one side of the moon, because it revolved on its own axis in the same time as it revolved round the earth. Upon its surface, seen from the earth, there were 1090 volcanic craters; it had also what at one time were supposed to be its seas, but these were not level. There were no level spots on the surface to indicate water; in fact, not a single drop was to be seen. How, then, was he to say there was water in the moon? These volcanic craters were proof there had been volcanic action, and there were also several *old sea-beds*, and about these were cliffs, and all the appearances which geologists recognised as the appearance of old sea-beds in the earth; there were the cliffs surrounding them, about which he could tell more than about the cliffs in the Mediterranean. The moon was being surveyed by a number of gentlemen called the Lunar Surveyors, and at the request of Professor Philips he (the lecturer) had assisted him in surveying the *Mare Humorum*, and had measured the height of the hills and the depths of the basins. Round some of these old sea-beds were cliffs similar to those existing near Seaham, and he believed the time was when these beds were filled with seas. The assumption was that there was now neither air nor water, but he differed from that. Earthquakes, in many cases, he explained, were caused by water finding its way through cracks and crevices in the crust to the internal fires of the earth, and volcanic eruptions in the moon had been caused in the same way. If water had been in the moon, where was it now? He had reason to believe that they had the same amount of water on the earth as was put on it in the creation; *not a drop of it could get away*; it might have taken up the solid or the gaseous form, but it could not rise above three or four miles, and certainly not a drop could escape above the atmosphere, which was forty miles, for beyond that not a drop of water could go. And the same with the moon; he believed that water once in it could not get away. Volcanoes also indicated to his mind that there must have been air to support combustion, and if it was there once it must be there yet, and he staked his reputation as a chemist and physicist that it was there yet, though the surface of the moon presented now no appearance of the presence of either air or water. Though they could never see what was on the other side of the moon, he felt that he had a key which admitted him to the secret of what was at the back of the moon, and it was that as water ultimately found the lowest level, it had made its escape to the lower or furthest side of the moon, and was congregated there. In fact he stated that every volcanic crater and sea-bed were to his eye visible footprints of air and water which once existed there, but which have now receded to more convenient quarters. From these arguments, he deduced that there was water and air in the moon, and that the moon was, therefore, a habitable globe.—*Sunderland Times.*

---

* Except that it has a slow motion, as the Earth also has.

BRIEF CORRESPONDENCE.

CONSTRUCTION OF OBSERVATORIES.—I should be much obliged for information as to the working of flat or shutter roofs for an observatory; are they suitable for a large achromatic telescope? and where could I obtain a plan or specification of one that would be rain-proof?—P.

STATISTICS OF OBSERVATORIES.—Turning over my papers last night, I came upon one of the blank forms, issued from your office some time ago to be filled in, to furnish a statistical account of the various private observatories in the United Kingdom. Permit me to enquire with all respect what has become of all the returns which were sent in to you, and are they likely to be put in print? for they would supply, I should think, a very interesting mass of information.

March 4, 1869. G. F. CHAMBERS.

[The returns sent to us were handed to Mr. De la Rue; a short epitome was inserted in the *Register*, Vol. 4, p. 21. We have heard nothing more on the subject since that time.—ED.]

URANUS.—Has your attention been called to the statement that Father Secchi has written a letter to the French Academy of Sciences in which he states that the spectrum of the planet Uranus is entirely different from that which it would give if shining only by reflected solar light, as the whole of the orange and yellow of the sun's spectrum is completely annulled? He says it is otherwise quite different from the solar spectrum, but does not explain the phenomenon. Perhaps you may think the above-named letter of Father Secchi (if it be authentic) worthy of notice in the *Register*.

J. GILBY.

WINNECKE'S COMET, we are informed, has at length been detected in Canes Venatici; but at present it is so extremely faint as to be imperceptible, except to very powerful instruments. It is also in a region abounding with small nebulæ, which adds to the difficulty of distinguishing it.

VARIABLE STAR IN GEMINI.—Mr. Birmingham is now closely watching a star in this constellation, which he suspects to be variable. Since first observing it, it has gone down three magnitudes; but it must again increase before its character can be decided.

LIST OF SUBSCRIBERS—Name received since our last number.

Brown, Alex. Esq., 94 Kepty Road, Arbroath.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To December 1868.

Dallmeyer, J. H.
Price, J. G.

To June 1869.

Cotsworth, H.
Forward, R.
Guyon, G.
Jackson, Mrs.
Lewis, H. K.
Ryley, F. B.
Vertu, J.
Wright, W.

To September 1869.

Burlingham, R.
Lowe, E. J.

To December 1869.

Abbott, F.
Anthony, Dr.
Baxendell, J.
Mestayer, R.
Roberson, C.

April 24, 1869. Subscriptions after this date in our next.

NOTICES TO CORRESPONDENTS.

Several communications are unavoidably deferred

ERRATA. In Table of Occurrences in last number: Illuminated portions of disk of Venus, *for* 1,000 *read* 0·995; and of Mars, *for* 0·894 *read* 0·914

ASTRONOMICAL OCCURRENCES FOR MAY 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.		h. m. s.		h. m. Arcturus
Sat	1		Sidereal Time at Mean Noon, 2 37 48·4	The Satellites of Jupiter are invisible until the 14th of this month, Jupiter being too near the Sun.		11 30·0
Sun	2	13 55 14 58	Occultation of B.A.C., 7202 (6) Reappearance of ditto			11 26·1
Mon	3	1 40	☾ Moon's Last Quarter			11 22·1
Tues	4		Meridian passage of the Sun, 3m. 24s. before Mean Noon			11 18·2
Wed	5					11 14·3
Thur	6		Illuminated portion of disk of Venus, = 1·000 of Mars, = 0·894			11 10·3
Fri	7					11 6·4
Sat	8	20 23	Superior Conjunction of Venus			11 2·5
Sun	9	14 32	Conjunction of Moon and Jupiter, 4° 9′ N.			10 58·5
Mon	10					10 54·6
Tues	11	2 55 4 7	Conjunction of Moon and Venus, 4° 33′ N. ● New Moon			10 50·7
Wed	12	7 56	Conjunction of Moon and Mercury, 6° 34′ N.			10 46·7
Thur	13					10 42·8
Fri	14					10 39·9
Sat	15	6 44	Conjunction of Moon and Uranus, 2° 37′ N.			10 35·0

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Sun	16		Sidereal Time at Mean Noon, 3 36 56·7			Moon — 4 18·3
Mon	17		Meridian Passage of the Sun, 3m. 50s. before Mean Noon			5 14·1
Tues	18	9 30 10 1 10 10 10 25	☽ Moon's First Quarter Occultation of Regulus (1½) Reappearance of ditto Conjunction of Moon and Mars, 0° 2′ N.	2nd Ec. D.	15 12 28	6 8·9
Wed	19					7 2·4
Thur	20					7 54·8
Fri	21		Saturn's Ring: Major Axis=41″·5 Minor Axis=18″·5			8 46·7
Sat	22					9 38·8
Sun	23	14 36	Conjunction of Mars and Regulus, (11 m.·7) W.			10 31·5
Mon	24	6 47 7 41 11 26 12 40	Occultation of γ Libræ (4½) Reappearance of ditto Occultation of η Libræ (6) Reappearance of ditto			11 25·3
Tues	25	3 23 20 29	○ Full Moon Conjunction of Moon and Saturn, 2° 27′ S.			Arcturus — 9 55·6
Wed	26					9 51·7
Thur	27			2nd Sh. E. 3rd Tr. E.	14 55 15 37	9 47·8
Fri	28					9 43·8
Sat	29	6 35	Greatest easterly elongation of Mercury, 23° 12′			9 39·9
Sun	30	14 52 16 11	Occultation of ι Capricorni (4½) Reappearance of ditto			9 36·0
Mon	31	12 44	Near approach of Moon to ι Aquarii (4)			9 32·0

THE PLANETS FOR MAY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	3 17 43	+19 5½	5″·2	0 24·1
	20th	5 16 23	25 23½	6″·6	1 23·4
Venus	5th	2 51 46	+15 41½	9″·6	23 54·3
	20th	4 1 38	20 17	9″·6	0 8·9
Mars	5th	9 45 21	+15 34½	9″·4	6 50·7
	20th	10 7 36	13 11½	8″·6	6 13·8
Saturn	5th	16 59 31	−20 58½	16″·6	14 3·6
	20th	16 55 23	20 52	16″·6	13 0·5
Uranus	5th	7 2 7	+23 6½	3″·8	4 7·9

AN OCCULTATION OF THE BRIGHT STAR REGULUS will take place on the 18th of this month at one minute past 10 o'clock in the evening; the star, however, disappears for ten minutes only. On the same evening, about a quarter of an hour afterwards, the planet Mars is in conjunction with the Moon, and only two minutes of arc to the north. On the morning of the 23rd, Regulus is about twelve minutes in Right Ascension to the West of Mars.

KEITH JOHNSTON'S ATLAS OF ASTRONOMY.—A new and enlarged edition of this well-known work has just been published by Messrs. Blackwood & Sons, of Edinburgh and London. It is illustrated with twenty maps and plates beautifully printed in colours, and accompanied by an elementary Survey of the Heavens by Mr. Grant, the Director of the Glasgow Observatory. This treatise forms by itself a very excellent introduction to the study of the science, and the information is brought up to the most recent period. Among the illustrations will be found excellent representations of the star spectra; also copies of the recent lunar photographs, correct drawings of Jupiter, Saturn, Mars, &c. The Atlas is got up with all the care and attention habitually paid by Mr. Keith Johnston to works of this nature; and published, as it is, at a moderate price, will be found an acquisition to amateurs, more especially to the young.

THE MARE SERENITATIS.—Mr. Birt's Map and descriptive Craterology of the *Mare,* the result of a careful collation of existing authorities, is now in course of distribution to subscribers to the Lunar Map and Catalogue.—Address, Cynthia Villa, Walthamstow, Essex.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 78. JUNE. 1869.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868-9.
Seventh Meeting, May 14, 1869.
Admiral Manners, *President*, in the Chair.
Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Minutes of the last meeting were read and confirmed.

Twenty-nine presents were announced, and the thanks of the Society given to the donors. Attention was directed to the two engravings of the great nebula in Orion, as seen in Lord Rosse's telescope, mentioned at the last meeting, which were now framed and suspended in the room. One was white upon black, the other black upon a white ground.

J. Knox Laughton, Esq.
William L. Lancaster, Esq.
Thomas Cooke, Esq.
Dr. F. Brunnow, Astronomer-Royal for Ireland, and
Rev. R. Crowe,

were balloted for and duly elected Fellows of the Society.

The following papers were read, or had their titles announced:

On the Opposition of Mars: by Mr. Joynson. The author sent a large number of drawings of the disc of Mars taken near the time of opposition in February last. They were selected from about 90 made, notwithstanding the weather was generally unfavourable. The pictures on each sheet represented the same phase of the planet, and although there were differences, he did not think these indicated any absolute change from former drawings. The return of separate points of detail in due course was affected by the eye-piece used, and the state of our atmosphere. With respect to the reddish colour of the planet, Mr. Joynson was disposed to think it depended more upon the state of our atmosphere than upon the material composition of Mars.

The President said these careful and continuous series of drawings became more and more valuable as time passed on, enabling them to be tested by comparison with those made at future oppositions.

Mr. De la Rue remarked that, while acknowledging the value of Mr. Joynson's systematic observations, he could not agree with his notion that the colour of Mars was due to the earth's atmosphere. His observations had been very numerous, and although our atmosphere might allow more or less of the red tint to be seen, it was, he felt sure, due to the structure of the planet itself.

Observations of Winnecke's Comet: by Mr. Wortham.

The comet has been seen as a hazy patch, and some positions in April and May were given. The author offered to send future places if required.

Remarks on Mr. Joynson's Paper on Occultations: by Mr. Plummer.

In his paper last March Mr. Joynson noticed that the times differed from those in the *Nautical Almanac* more than he thought they ought. Mr. Plummer, believing that the times were generally correct, recomputed them, and also with proper allowance for the latitude and longitude of Liverpool, and found upon comparison that the observations and computations were sufficiently accordant, with one exception. He also called the attention of observers of occultations at a distance from Greenwich to a paper by Professor Chevallier, on the effect of parallax in such cases, with tables of corrections, and stated he should be happy to compute similar tables for any other locality on the same plan.

On the Period of η Argus: by Professor Loomis.

In a discussion of the observations of this star by Professor Woolf, in the *Ast. Nach.*, he arrives at the conclusion that they represent a period of 46 years; but the observations of Mr. Tebbutt show that this is too short, and Professor Loomis finds that they are best satisfied by a period of 67 years. Future observations may require some alteration, but at present a period of about 70 years seems the best. Tables of maxima and minima and a light curve accompanied the paper.

On the same Star: by Mr. Tebbutt.

The author stated that he had read with great interest the papers by Mr. Abbott and Sir John Herschel on the variability of η Argus and its surrounding nebula. He had watched the object for 15 years, and during the last 12 months with the greatest care, as it seemed to be approaching a minimum. He had compared it with the stars named by Sir J. Herschel, using a telescope of 3¼-inches aperture, and also observed the stars of comparison with the transit instrument, and found their places agreed with those of Sir John's catalogue. Tables of the comparisons were given, and the result showed a variation from the 1st to the 6th magnitudes.

On a remarkable Sun-Spot observed on May 1, 1869: by Mr. Bidder.

The author exhibited and described a drawing made by him, and called attention to the remarkable spiral arrangement of the spot. One portion was crossed by an attenuated bridge, which showed the same structure. The penumbra was 27,000 miles long. His telescope was of 7-inches aperture, and although time failed him to show all the detail, the appearance was most striking. He fancied the bridge referred to was not in the same plane as another one.

The President enquired whether Mr. Lockyer had seen this spot?

Mr. Lockyer said he had seen it in several stages of development, and could corroborate the tendency to a cyclonic form. Every observation of a sun-spot made one feel he was in the presence of a grand phenomenon.

Mr. Stone: Father Secchi states that he has seen a bridge split up into detached points of light.

Mr. Browning: I have seen this several times.

Mr. Stone said he still believed in the bodies which he called rice-grains.

Mr. Lockyer mentioned that in 1865 he saw all over the sun, except at the limb, things like spots with untidy borders, and the same bodies were shown in what had been irreverently termed Mr. Huggins's "floor-cloth pattern." When they got to the penumbra of a spot, they became elongated. He thought these things suffered changes on the spots but not on the sun's body.

Mr. Stone: I think they change form on the sun as well.

Mr. Howlett remarked the extraordinary resemblance of the spot seen by Mr. Bidder to one drawn by him in October 1865. It had the same spiral arrangement, and Chacornac also gave a representation of it. He never saw two so much alike.

On a Sun-Spot observed March 14, 1869: by Mr. Browning.

About 9·30 A.M. the author saw a large spot which had just come on the edge of the sun. It was 20° N. of the equator, and only 2′ from the east limb. The telescope was his 12-inch reflector, with powers of 140 and 248, the definition being good. The light could be modified to any extent by a silvered reflector and achromatised wedge of neutral tint glass, which Mr. Browning exhibited to the meeting. The dimensions of the spot were from N. to S. 14,400 miles, and from E. to W. 19,600 miles, although in this direction it looked smaller from the foreshortening. The size had been calculated by Mr. Proctor. In the umbra were three nuclei, like an equilateral triangle. Markings existed all over the umbra. In the darkest spot were two ridges at an angle of 40°, like broken bridges. The edge of the penumbra furthest from the limb was full of faculæ. The extreme edge of the penumbra was darker than the rest. This had been doubted, and the effect attributed to contrast, but if the spot were spirally arranged it would present such an appearance. The photosphere was covered with bodies like broken branches and small leaves. These granules differ very much in form, and may be called rice-grains, willow leaves, broken twigs, &c. Mr. Howlett's drawings showed many curious and regular forms of sun-spots, also masses like those of clouds in a "mackerel" sky. He had felt some doubt as to the propriety of taking up the time of the Society with such observations, but further consideration showed that they were of interest, and that stupendous activities were connected with sun-spots. If this view were taken by the Fellows, he might continue his work on the spots occasionally.

The President said Mr. Browning must know the importance of such observations was not measured by their value at the moment, but that, as time progressed, it became more apparent.

Mr. Huggins: At a distance from the neighbourhood of spots, the changes in the luminous bodies are not very great. The diameters of the granules are generally about 3 to 1. My experience agrees exactly with Mr. Browning's observations of the appearances near spots.

Professor Brayley suggested that it would be a desirable object of enquiry whether bridges, of which the drawings exhibited by Mr. Bidder and Mr. Browning of the sun-spots observed by them presented remarkable instances, were not in reality faculæ over the spots, viewed from above, of the nature of the floating faculæ photographed by Mr. De la Rue. And in reference to his own opinion on the related subject of the identity, or partial identity, as physical objects of faculæ and prominences,* and their dependence on the torrents forming the spots, he cited Mr. Huggins's observation of a spectrum of bright lines seen over the umbra of a spot. With reference to what had been stated by Mr. Bidder and Mr. Browning respecting the occurrence of several nuclei in the umbra of the spots they had observed, he called attention to Sir John Herschel's figures of sun-spots in the "Cape Observations," among which he believed were the first recorded observations of such nuclei, though it was reserved for the late Mr. Dawes, who re-observed them, to recognise their nature as evidencing the existence of a region of the sun before unknown. Mr. Dawes's figures, however, gave only a single nucleus to a spot, nor did he describe more, while Sir J. Herschel had represented cases in which nuclei appeared to be disseminated, as it were, in the umbra, an approach to which had been observed by Mr. Bidder and Mr. Browning in the spots they had just described.

---

* See *Monthly Notices* for January, vol. xxix. p. 91.

Mr. Huggins said he was enabled to add, in support of Professor Brayley's opinion that bridges were faculæ, his own observation that they were the brightest objects on the solar disc, exceeding the average brightness of the photosphere. He also stated that he had observed that there were commonly several nuclei in one umbra of a spot, and most frequently three.

Mr. Browning made drawings of objects of several forms and magnitudes observed by him on the photosphere in the vicinity of spots.

On these Professor Brayley remarked that, while one of them was identical in figure with the typical willow-leaves of Mr. Nasmyth, others were among the shorter forms (including Mr. Stone's rice-grains) described in a letter from Mr. Nasmyth which the speaker had read to the Society several years ago. He also pointed out that the bridges were the brightest parts of the drawings now exhibited.

Colonel Strange: May not that be the effect of contrast?

Mr. Browning: I made ample allowance for this.

The President called attention to the fact that the meeting was favoured with the presence of Professor Newcombe and Professor Lyman, of the United States, and invited these gentlemen to consider themselves as members, and make any remarks that occurred to them during the discussions.

Professor Lyman said they could not consider themselves strangers after the cordial reception they had met with. Regarding sun-spots he had observed them much with a 9-inch refractor, and could corroborate the appearances described, especially the behaviour of the granules in elongating and separating on approach to the umbra or penumbra of a spot; also the great rapidity of the changes of these small bodies, which in a few minutes caused a row of granules to combine or separate, entirely changing their form. He had not followed up the observations to the extent of those on this side, but could generally confirm what had been said.

On a method of imitating the Transit of an inferior Planet: by Mr. Hollis.

The possibility of such an operation having been mooted at the last meeting, the author described an experiment in which a leaden ball was suspended by a wire to a spar projecting from a tower 150 feet high. With a 6-inch refractor, at a distance of 186 yards, he observed the ball upon the sun's disc, and during its rapid passage over the limb, found the black ligament distinctly visible.

On the Transit of Venus: by Mr. Proctor.

The author gave an oral account of the principal points of this paper, the object of which is to show that Halley's method of observing the whole duration of a transit is applicable to the transit of Venus in 1874, although the Astronomer-Royal thought it would not be, and recommended observations of the absolute times of ingress and egress at different stations only. Mr. Proctor also thinks that Halley's plan, which the Astronomer-Royal wished to follow in 1882, will totally fail at that transit in consequence of the impossibility of attaining a southerly station with the sun at a sufficient altitude. At any such places there is a wall of ice 100 feet high, and access is not to be hoped; while at Sabrina and Victoria Land, which Mr. Airy pointed out as suitable, the sun will be less than 10° high, and Mr. Stone has stated that observations in this case will be useless. The author exhibited and explained a set of maps, prepared with great care, having curves showing the parallax factors and sun's altitude, and from these deduced that the places of greatest acceleration and retardation of the ingress and egress in 1874, as given by Mr. Airy, were incorrect to an extent varying from 200 to 900 miles. He concluded, therefore, that the transit of 1874 was superior to that of 1882 in the advantages offered by its observation in the proportion of 25 to 21, after giving due consideration to Mr. Stone's remarks on the slower motion of Venus producing clinging to the limb at the former epoch.

Mr. Stone said no one but must be grateful for Mr. Proctor's excellent maps, and the trouble he had taken, but he (Mr. S.) must enter his firm protest against the idea that the Astronomer-Royal had been guilty of any inaccuracy. Mr. Airy had stated his maps were obtained by projection from a globe, and the results were only approximate, but sufficient for selecting observing stations. He (Mr. Stone) had gone over the work, and was unable to find any fault in it. The absolute points might be as Mr. Proctor said, but the matter was the choice of stations, and these were mainly still retained in Mr. P.'s suggestions. With regard to the omission of Indian stations, it was done because several inRussia were recommended, and Alexandria was preferred as nearer, and able to have the longitude very accurately determined. Another reason for discrepancy in the results of the two calculations was, that there were two phenomena to be observed, external and internal contacts, of which Mr. Proctor selected the latter, but Mr. Airy adopted the mean. This made a difference of a certain number of miles, but this was of no material consequence. In a book of Mr. Proctor's the places of stars were given to the nearest minute, and this would involve an average error of 450″, which it might be said involved an error at the distance of α Centauri of many times 91 millions of miles. This might be thought a ridiculous error, but the places given were quite sufficient for picking up the stars, and so the charge as to the Transit Stations might likewise be answered. M. Puiseux has also called attention to the necessity of employing the method of duration in 1874.

Mr. Proctor was not desirous of making any charge against Mr. Airy, but wished only to procure the selection of the best stations. The large number of miles referred to by Mr. Stone in the places of stars was of no moment for the purpose the places were used, but 900 miles was a large quantity in relation to places on the earth. It was not a question of which was the best method, but which was the best available. He could quote Mr. Airy against Mr. Airy. At first the Astronomer-Royal stated Halley's method was totally inapplicable in 1874, but now he hopes it will be tried. The reasons for selecting the passage of the centre are not sufficient, as the limbs are not equally affected.

The President observed that the maps and suggestions of the Astronomer-Royal were, he believed, not intended to be definitively adopted, but were brought forward with the view of getting the question discussed, and the best information obtained, and not, as Mr. Proctor seemed to think, for decisive and absolute adoption. Astronomers were much obliged to Mr. Proctor and others for criticising and improving the suggested plans. He thought it was Mr. Airy's wish to have them canvassed, and Mr. Proctor was doing good service by his contributions.

Mr. Proctor: This is quite my feeling. No one can have greater admiration for Mr. Airy's splendid talents than I have, but I thought it right to make known that in some parts where the Astronomer-Royal points out a very few places, there are many others quite as important.

Mr. Stone: The selection of stations was the only object of Mr. Airy's paper, and it was not meant to be critically treated with regard to a different phase, which would, of course, give a different result.

Mr. De la Rue: I believe Mr. Airy wished his conclusions to be discussed and tested. It appears his calculations are for one contact, while Mr. Proctor uses another.

Mr. Proctor: It is quite unnecessary to impugn the accuracy of another computer. It is best to look on both as original investigations.

Mr. Browning wished to point out the exceeding accuracy of the maps exhibited by Mr. Proctor. He had tested the position of 20 places by the tables, and in 19 out of the 20 they were correct within 4′ of a degree. If diagrams generally were equally correct, it would be a matter of great congratulation.

Mr. Proctor said he must beg to remove any impression that he was bringing any charge against the Astronomer-Royal; but in a matter of such scientific importance accuracy was the supreme consideration, and Mr. Airy, he felt sure, would be the first to appreciate his efforts to prevent an expedition being sent out uselessly.

Mr. Stone would repeat that, if the maps were sufficiently accurate for choosing the stations, that was all that was intended, and he would not further prolong the discussion.

The President: It is really an attempt at a closer approximation.

On the Preparations desirable for Photographic Observations of Phenomena such as Transits of Venus: by Major Tennant.

Mr. De la Rue having advocated the claims of photography for observing these phenomena, the author was of opinion that the value of the method was probably very great, and proceeded to point out several precautions to be taken and to make suggestions towards a successful result. Every effort should be made to get rid of instrumental distortion, so that when an enlarging lens was used this should not be increased. An unsilvered reflector would diminish the light, and either the Newtonian or Cassegrainian form (the latter he thought the better) might be adopted. The instantaneous shutter had hitherto been worked by burning a thread, but he thought an electro-magnetic break would be very preferable. A repeating slide would also be desirable, so that several observations could be taken on one plate. One advantage not noticed by Mr. De la Rue was, that stations might be multiplied. They might be placed 100 or 200 miles apart, and thus the reliance on the measures greatly increased. The photographs might be enlarged by a special lens, as the Guntoor photographs had been, and all micrometrical measures during the transit rendered unnecessary, as they could be done upon the pictures afterwards.

Comments upon Major Tennant's Paper: by Mr. De la Rue.

With respect to the choice of an instrument, the author thought that, although an unsilvered reflector might give an image more free from optical distortion than the Kew photo-heliograph which had an enlarging eye-piece, still, as it was impossible to enlarge the small pictures taken in the direct focus of the former instrument without distortion, the refractor and eye-piece might be advantageously retained. In a reflecting telescope there must be some means of getting rid of the light passing through the back of the mirror. If this were made convex, to disperse light, the heat would complicate the process and affect the photographs, while arrangements to avoid this would be difficult to contrive. A reflector without an eye-piece would give a small picture without distortion, but he should prefer the Newtonian form with a prism to the Cassegrain; but on the whole the refractor was the best form, as any distortion could be ascertained and allowed for. Next, as to the measuring instrument, he would point out that the one described in the *Philosophical Transactions*, and used for the eclipse photographs, was much more delicate than Major Tennant imagines. It has a micrometer screw, and there are practically no limits to the dimensions measured. It is certainly detrimental to enlarge photographs, but by care all the requirements of Major Tennant might be obtained, and if several stations were used a few photographs at each would give the position of Venus at any given moment.

A gentleman enquired whether curved plates could not be used? They had been for landscapes.

Mr. De la Rue: This was suggested by M. Porro, but the disadvantages are greater than the gain. The amount of distortion can be ascertained by taking pictures in different parts of the field, and then it can be allowed for.

Professor Lyman: There is a single point which I am happy to be able to bring before the Society in connection with the transit of Venus, and that is with reference to the appearance of Venus near the sun at its inferior conjunction. In 1866, when the planet passed within 22′ of the sun's limb, I was observing it. Had this happened 24 hours' earlier there would have been an actual transit. As it was, it gave me the opportunity of testing the great effect of the atmosphere of Venus in prolonging the cusps of the planet. Madlër, in 1849, found them extending 240°, but I saw Venus much nearer, and saw the line extending gradually until, when within 1° 30′ of the sun, the delicate ring entirely surrounded the planet, and this was followed till Venus was within 1° 8′ of the limb. The following day the conjunction took place, and the day after that again, at a distance of 1° 20′, the ring was seen. The telescope was a 9-inch refractor. No special screen was used, but the shutter of the dome partly cut off the light. The ring was not uniform in brightness, for, about 45° or 50° from the point of the disc, directly opposite to the sun, there was a diminution of light, and also in another part. In fact there were two breaks, and this in the reflected crescent and not at the cusps, as if there were mountains at these points. On the day of conjunction, the sun being behind a chimney, with a smaller telescope I saw the planet easily; and on the following day, with the large telescope, the sun being covered by a cloud for a moment, I had a beautiful view of the silver thread surrounding the planet. If these observations were borne in mind, they might be repeated before and after the approaching transits, and with proper screens Venus might, perhaps, be followed up to the beginning of the passage over the sun.

Mr. Lockyer: It may be in the recollection of the Fellows that

Dr. Wollaston recommended this method of observing, to determine the density of the atmosphere near the sun, and that he lost the planet at about a distance of 1°.

The President said that a gentleman present was desirous of making some remarks upon the effect of the moon on the earth's temperature, and knowing that Professor Loomis had discussed that subject, the meeting would be glad to hear anything Professor Newcombe could tell them with respect to it.

Professor Newcombe replied that, with respect to the observations of Professor Loomis on the moon's effect, he had not received any communication from Professor Loomis.

Mr. J. Park Harrison wished to state that he had received a pamphlet from America, entirely corroborating his paper read about a year ago, and showing that Professor Loomis obtained the same result. Madlër tabulated the temperatures at Berlin, and found the highest temperatures at the moon's first quarter. The speaker had done the same for Greenwich and Oxford. Mr. Ellis had tested his result at Greenwich, and now Professor Loomis confirmed it at Philadelphia. The effect of the moon was 2½° in Europe, but only 1½° at Philadelphia. It might be taken as certain that the moon produced heat at this time.

On the Solar Eclipse of 1871 : by Major Tennant.

On the Solar Eclipse of August 1869 : by Mr. Paine.

On the Determination of the direction of the Meridian with a Russian Diagonal Transit Instrument : by Mr. Clarke.

On the Probable Error of Greenwich Observations in Zenith Distance, estimated by Discordances from the Separate Means : by Mr. Stone.

Mr. Huggins read extracts from a letter written by Mr. Baxendell to him respecting the recent discussion on the *Corona at Eclipses*. Observations indicate that this is not an appendage to the sun, and Mr. Baxendell's idea is that an irregular nebulous ring round the sun, nearly in the plane of the eclipse, will account for the appearance. The suggestions of M. Faye and Mr. Airy are quite inadmissible. No part of the earth's atmosphere could produce it, nor could the moon. The different accounts of its appearance result from the observer's eyes and conditions of atmosphere differing. The rays and streamers Mr. Baxendell regards as totally different things from the corona itself. Mr. Huggins also wished to correct a statement he made at the last meeting, that Struve first saw the bright line in the aurora borealis. In point of fact Angstrom first observed it, and had his result confirmed by Struve. Angstrom had also found the same line in the zodiacal light, which was a remarkable circumstance connecting phenomena generally considered of a very different character.

The meeting then adjourned.

THE TOTAL SOLAR ECLIPSE OF AUGUST 1868.

Report of M. Janssen (*continued from page* 110).

Part II.

I now return to the protuberances. During the total obscuration I was struck with the extreme brightness of the protuberential lines; and the thought occurred to me immediately that it might be possible to see them without an eclipse. Unfortunately the weather, which clouded up after the last contact, did not permit me to attempt anything more on that day.

During the night the way and means of performance presented themselves clearly to my mind. The next day, 19th, I rose at 3 o'clock in the morning to prepare for the new observations.

The sun rose very beautifully. As soon as it was free from the mists of the horizon, I began to explore it in the following manner. By means of the finder of my large telescope, I placed the slit of the spectroscope on the edge of the solar disc, in the same place where, the day before, I had observed the luminous protuberances. This slit, placed partly on the solar disc and partly outside it, would show, consequently, two spectra, that of the sun and that of the protuberential region. The light of the solar spectrum was a great difficulty. I turned the spectroscope so as to get rid in the solar spectrum of the yellow, green, and blue, the brightest parts. All my attention was directed to the line C—dark for the sun, bright for the protuberance—and which, falling in a less luminous part of the spectrum, ought to be much more easily perceptible.

I had been some little time studying the protuberential region of the western edge, when I suddenly perceived a little red line, very bright, between one and two minutes high, forming an exact prolongation of the dark line C of the solar spectrum. By making the slit of the spectroscope move in such a way as to sweep methodically the space which I explored, I found this line remained persistent, but it was modified in its length and in the brightness of its different parts; showing a great variability in height and luminous power of the different regions of the protuberance.

This search was repeated at three different times, and the bright line always appeared under the same circumstances. M. Rédier, who assisted me with much energy in these observations, saw it likewise, and soon we were even able to foretell the appearance solely by the knowledge of the explored regions. Soon after, I found that the bright line F showed itself at the same time as C.

In the afternoon I returned again to the region studied in the morning. The bright lines showed themselves anew, but they evidenced great changes in the distribution of the protuberential matter: the lines break up sometimes into separate little bits, which do not form again into the principal line, in spite of the slit being removed. This fact indicated the existence of isolated clouds which had been formed since the morning. In the region of the great protuberance I found several bright lines, but their length and distribution showed great changes.

Thus was demonstrated the possibility of observing the lines of the protuberances without eclipses, and, thereby, a method for the study of these bodies at our leisure. These first observations already showed that the coincidence of the rays C and F was very precise, and that hydrogen really formed the foundation of these circumsolar matters. They establish besides the rapidity of the changes which these bodies undergo, changes which could only be surmised during the very brief observations of eclipses.

During the following days I took advantage of every opportunity that the state of the heavens offered for applying and perfecting the new method; as much, at least, as the instruments would permit which had not been constructed with this object in view.

Following, with much care, the protuberential lines, I have sometimes observed that they penetrate the dark lines of the solar spectrum; thus indicating a prolongation of the protuberance on the solar globe itself. This result was easy to foresee; but the interposition of the moon had always rendered the proof of it impossible during eclipses.

I must here refer again to an observation made on 4th September, in favourable weather, and which showed with what rapidity the protuberances were changed in form and displaced.

At 9h. 50m. the inspection of the sun indicated a mass of protuberential matter, at the lowest part of the disc. To determine the shape, I made use of a method which may be called chronometrical, as time comes into play as an element of measure.

In this method the telescope is placed in a fixed position, so that, by the effect of diurnal rotation, every part of the region to be explored may come successively in front of the slit of the spectroscope. We then notice for each fixed period the length and situation of the protuberential lines, which are successively seen.

The time that the solar disc takes crossing the slit gives the value of a second and minute of arc.

This being known, combined with the length of the protuberential lines, measured in the same manner,* furnishes the elements of a graphic representation of the protuberance.

The application of this method to the study of the solar circumference indicated a protuberance extending over a length of about 30 degrees, of which 10 degrees were east of a vertical diameter of the sun, and 20 degrees to the west. Towards the extremity of the western portion, a considerable cloud rose to an elevation of 1½ minute from the globe of the sun. This cloud was more than two minutes long, and for one minute extended itself parallel to the solar limb. An hour after (10h. 50m.) a new drawing showed that the cloud was rapidly elevated, and taking a globular form. Soon after the motion became still more rapid, for ten minutes later, that is to say at 11 o'clock, the globe was enormously lengthened in a normal to the solar limb, or perpendicular to the first direction. A little mass of matter was detached from it at the under part, and was suspended between the sun and the principal cloud. The weather, which now clouded up, would not allow us to pursue our researches. Let us now sum up the results of these observations.

Taking first the principle of the new method, it rests on the difference of the properties of the light of the protuberances and of the photosphere when acted on by the spectroscope. The light of the photosphere, emanating from solid particles or incandescent liquids, is incomparably more powerful than that of the protuberances due to a gaseous radiation. It has, therefore, up to this time, been almost impossible to perceive the protuberances without an eclipse; but, by the use of spectrum analysis, we can reverse the terms of the question. By the dispersion of the prisms, the solar light is spread over the whole extent of the spectrum, and by that means it is much weakened. The protuberances, on the contrary, only give rise to a small number of bright lines, the intensity of which remains very similar to the corresponding solar lines. It is thus that the protuberential lines are perceived very easily in the field of the spectroscope, under the ordinary solar spectrum, whilst direct vision of the protuberances is, as it were, extinguished by the dazzling light of the photosphere. Another very fortunate circumstance contributes to this favourable state of things. In reality the bright lines of the protuberances correspond to the dark lines of the solar spectrum; it follows from this that not only are they more easily perceived in the spectroscope, on the border of the solar spectrum, but that it is even possible to see them in the interior of this spectrum, and thereby trace the outline of the protuberances on the solar globe itself.

---

* This estimate is obtained in an easy way, by placing across the slit of the spectroscope two wires, the intersection of which, at the focus of the collecting lens, represents a definite number of minutes of arc.

With respect to the determination of the chemical elements, the method followed during total eclipses has always carried with it some uncertainty. In the absence of the solar light we are obliged to have recourse to the aid of scales to fix the position of the lines of the protuberances, but the new method allows us to compare directly the protuberential with the solar lines, and the identification of substances is then absolutely certain.

During the short period which I have been enabled to apply my new method of perceiving the protuberances, the results obtained allow me to consider as proved:

1st. That the luminous protuberances observed during total eclipses belong, without doubt, to the regions surrounding the sun.

2nd. That these bodies are composed of incandescent hydrogen, and that this gas predominates, if it do not form their exclusive component.

3rd. That these circum-solar bodies are the seat of motions, of which no terrestrial phenomena can give any idea: masses of matter, many hundred times greater than that of the earth, completely shifting and changing their form in the space of a few minutes.

Such are the principal results obtained. I hope that notwithstanding the state of my sight, which has suffered by my long-continued observations on light, I shall be able to resume my labours. I shall have the honour of submitting these results to the Bureau des Longitudes.

I will only add, in conclusion, that I have taken advantage of the opportunity to continue my observations on the spectrum of the vapour of water, which was afforded by the climate of India being very moist at the time of my visit, and therefore very favourable to such researches. They have induced me to attach an importance to the spectrum of this vapour which daily increases. My experiments in Paris and here all lead me to recognise an elective action on the whole of the solar radiations; although, in the dark rays, both of the ultra-violet and the violet rays, the elective action may be much more difficult to prove.

These results will form the subject of a separate communication.

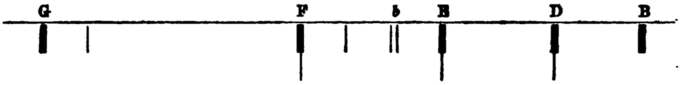
Report of M. Rayet.

The apparatus which I used at Wah-Tonne for the optical examination of the light of the protuberances comprised a reflecting telescope, with a mirror of silvered glass 20 centimetres in diameter, mounted equatorially for the latitude of the station, and of a direct-vision spectroscope. This last instrument was composed of three very dispersive prisms combined, so as to give a short length and the greatest amount of light.

Spectrum of the Cusps.—The slit of the spectroscope having been turned in such a way as to cut exactly at a right angle the image of the luminous crescent, which remained some seconds before the total darkness, I first examined the light at the extremity of the cusps. Upon the background of a spectrum of very well marked dark lines, formed by diffused atmospheric light, a much more luminous band was seen, which was the spectrum of the light emitted by the extremity of the cusp. In other parts nothing particular was distinguished. The lines seen, although stronger in breadth and intensity, presented an appearance identical with those of the ordinary solar spectrum.

The observation of the cusps was interrupted some seconds before the eclipse becametotal in order to remove the diaphragms used with the telescope, and to slightly open the slit of the spectroscope, so as to be prepared for the examination of the protuberances.

Spectrum of the Protuberances.—At the moment of total obscurity, the slit of the spectroscope having been placed on the image of the long protuberance which showed itself on the eastern edge of the sun, I saw, immediately, a series of nine bright lines, which, from their position in the field of view, their relation to one another, their colour, and lastly by their appearance as a whole, showed that they resembled the principal lines of the solar spectrum B D E *b*, an unknown line, F, and two lines of the group G. These lines had very great lustre, and stood out vividly from the ground of a very pale ash grey.



The protuberances are, therefore, jets of incandescent gaseous matter—the flames of a chemical phenomenon of very great power. It must alsobe remarked, that the light of the corona is very faint compared with that of the protuberances; for whilst the light of the latter gave a very bright spectrum, the former, notwithstanding the jaws of the slit were opened wider, did not give a spectrum with any perceptible colours.

During the preceding observations the slit of the spectroscope was parallel to the largest diameter of the protuberance, and the bright lines were then seen to have a sensible length in direct relation to the height of the prominences. The slit having been turned 90 degrees, the lines were found reduced to the appearance of bright points,agreeing with the smaller size of the luminous horn. No error in the observation was therefore possible, as the bright lines exactly represented the spectrum of the light of the protuberances.

The spectroscope being restored to the first position (that is, the slit parallel to the length of the protuberance), the very bright lines comparable with D, E, and F were seen to be prolonged beyond the mean length of all the lines, by a very weak luminous trace ; the spectrum presenting the appearance shown in the above diagram. A certain portion of the incandescent gaseous matter which forms the protuberances projects itself then into the solar atmosphere beyond the limits that the eye assigns in general to these bodies. Having finished the examination of this first protuberance, I placed the slit of the spectroscope on the extensive luminous region on the western edge of the sun.

The spectrum again showed itself to consist of bright lines situate as on the former occasion, only I saw but one single violet line. All the protuberances, therefore, do not seem to emit precisely similar light.

M. Hall, marine engineer of the Navy at Saigon, who observed at another part of our station, likewise found that the spectrum of the protuberances was composed of bright lines.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

"*CELESTIAL OBJECTS.*"

Sir,—In the absence of the Rev. T. W. Webb, who is I understand at present travelling on the Continent, I would respectfully submit it to you that what Mr. Chambers seems rather disposed, in this month's *Register*, to censure as a defect in the above work—viz., the omission of reference in each case to the authority quoted—may possibly have been, in another view, an essential part of the author's plan. A mere glance at the immense mass of information condensed in so small a compass in this book will suffice to show that a reference to authority in every case would not only swell the volume to double its present size, but—and which is more important—would double its cost also, and so place it beyond the reach of the very class of amateurs for whom it was evidently written.

I must confess it is sufficiently plain to me, from the author's introduction, that "Celestial Objects" was *not* intended for those readers who have access to the same standard astronomical works from which a large portion of its information has been so skilfully gleaned. And let me ask, what possible use could a mass of references be to those who have no means of verifying them? But Mr. Webb's fame as an original observer, as well as his known accuracy in recording the observations of others, place his works, in this respect, as far beyond all suspicion of error, as they are far above either praise or blame from me, or such as I am.

Yours truly,

Mill Park Manor, Enniscorthy, Ireland: G. T. F.
May 1869.

"*GRAND AURORAL DISPLAY,*" *MAY* 13*th*, 1869.

Sir,—A very remarkable display of this phenomenon was visible here last night. I was summoned at 10h. 15m. and told that the "lights" had been seen for about half an hour. On going out I saw a fine broad zone of milk-white light arched across the sky, and springing from the horizon on a bright base line extending from NE. to E. on one side, and on the other from W.S.W. to S.S.W. The coruscations met in slightly waving beams in a large irregular oval halo, about 15 or 20 degrees SE. of the zenith, a little above and N.W. of the conspicuous stars of Corona Borealis. This meeting-place remained fixed the whole evening whenever the beams reached overhead, though their bases were frequently changing. At this time the northern sky, near the horizon, was a fine dark blue, studded with stars, and quite untouched by the auroral cloud, though it fell down like a fine veil northwards from the zenith, nearly as far as Cassiopeia. Mars and Regulus were enveloped in the SW., and Vega was just upon the northern limit of the NE. beam; Arcturus was never reached.

At 10h. 40m. the most brilliant phase was reached. From N. to NE. the resemblance to the morning dawn was perfect; yellow and pink tints prevailed: in the SW. the beams were chiefly pink and bright blood-red. The smaller stars were much dimmed; I did not at first recognise Corona

Borealis. It being on record that the spots of Venus had been well seen in a red Aurora, I now tried Mars with a power of 200, but I noticed nothing remarkable. Saturn was well defined on the SE. horizon, but he was not near the Aurora.

At 11h. 5m. the streamers, now colourless again, went up from the North, and the shifting beams were breaking away from about Corona Borealis.

At 11h. 55m. the arch had fallen low and become contracted in breadth: it stretched from two or three points E. of N. to a little S. of W. Capella was just at the northern edge of the arch; Castor and Pollux in the clear blue below it; and there were short streamers from the N.

At 12h. 5m. short wavy streamers rose from the arch, and there was an appearance of a short lower arch much further away to the North.

At 13h. 15m. the arch remained as before, but reaching further S., and from it went strongly shooting vibrations; these increase, and beams too begin to rise lower than the arch and to obliterate it: they move grandly on from NW. to N. like sunbeams breaking from a storm-cloud. There is no cloud, but the auroral beams are so bright at the bottom that the sky beside them looks black; and in the root of one of them Cassiopeia is much obscured.

At 13h. 30m. there is a most beautiful play of shooting beams, meeting overhead, streaming from each horizon and palpitating violently: becoming stiller again as they grow more vivid; widening so as to cover all the space from NE. to SW., till at last there is one unbroken sheet of white light thrown like a veil of gauze over half the visible sky, and contrasting sharply with the unclouded blue. At length this vast auroral cloud begins to break up, shooting, quaking, dancing; till at 14h. 0m. the light is again concentrated on and above the horizon with a few shooting, vertical beams.

The sky was without a vestige of cloud, wind E. but very still, air cold, and a heavy dew falling.

This morning the weather is pretty much the same; but there is more wind, and cirrhus clouds and cirrho-stratus are deepening in as I write.

At the grandest display of colours two miners left the ale-bench. I heard them asseverate with many oaths they had not seen the like before. There was in their minds a little wonder, but no awe; and soon they went on together singing in stentorian chorus. A comet with a blood-red tail would not dismay us now-a-days; but would that morality and veneration went along *pari passu* with intelligence, and that superstition could be supplemented by religion!

I am, Sir, truly yours,
Ingleby Greenhow Vicarage, Northallerton: RALPH PROWDE.
Yorkshire, May 14th, 1869.

P.S.—I have not seen an Aurora with corona for more than twenty years. I am told that it was in the autumn of 1846; I have a vivid remembrance of the appearance, and I think that the corona was more brilliant on that occasion: it was visible as far south as Spain. The observations of the aurora in Lancashire agree well with my own, particularly as to the hours, position of corona, and the colours. I have only, however, mentioned the principal colours; other tints were present. None, however, of the observers, so far as I have seen, seem to have witnessed the beautiful display of white auroral light at 13h. 30m. R. P.

Sir,—The aurora on Thursday night, the 13th, was of a kind that I never saw or heard of before. I cannot call it an aurora borealis, for one of the two peculiarities of the phenomenon was that it was often the most brilliant in the south. Another characteristic was the intense red tinge that spread over the auroral columns of light. When I first noticed the phenomenon, about 10h. 15m., one would have had the idea that there was a bright moonlight or a strong twilight, but the moon had set three-quarters of an hour and the twilight had almost entirely vanished. At this time a thick column of light sprang up from the SW. and another from the NE. These met at a point exactly overhead. They were very vivid, but flickered very little. About ten minutes afterwards the sky suddenly became covered all over, east, south, north, and west, with columns of light. All converged to the zenith, giving the heavens almost exactly the appearance of an immense umbrella. At 10h. 35m. a rich carmine colour was visible in the SW., and almost immediately the aurora in the NE. was tinted with it. It gave one the appearance of a distant fire. This rosy patch was intensely brilliant in the SW., the planet Mars being in about the centre of it. Although there was no moon or twilight I could distinctly read the time on a small watch held at the distance of a foot from my eye. At 10h. 55m. the rosy colour was concentrated round Spica Virginis. When I last looked, at 12h. 25m., the sky was perfectly clear except in the north, where there was the ordinary or legitimate aurora borealis. A Fleetwood paper calls it "a curious aerial phenomenon of light clouds, variously tinted, coming to a point just over the office of their paper!"

I am, Sir, yours, &c.,

Lytham: May 17, 1869. S. J. JOHNSON.

Sir,—I beg to enclose you a paragraph taken from the *Belfast Morning News*, describing an *Aurora* seen here on the night of the 13th of May. The writer has not in the least exaggerated the splendid appearance presented by the phenomenon, which, I may remark, far surpassed any similar display I ever saw. It may be noted that on the following day a halo of great extent surrounded the Sun.

Yours very truly,

Carnlough: May 15, 1869. JAS. RESIDE.

"BEAUTIFUL ATMOSPHERIC PHENOMENA.—The most brilliant nocturnal spectacle in our recollection was seen in Belfast last evening from shortly before ten o'clock till after eleven. In the zenith, rather eastwards, a huge body of white electrical matter was concentrated; and from this nucleus there extended in a radiating direction over the whole body of the heavens innumerable streams of light of various colours, reaching to the horizon. Sometimes in the south one of the bands of colour would become a bright purple, and remain stationary for a moment or so; then it would break up, as it were, and diffuse itself into a band of a lighter hue, and a new and broader shade would be seen. Next one of the limbs branching from the central point would become a bright white, and then highly-arched rainbows, parallel to each other, would be displayed, the primitive colours being distinctly traceable. Nothing could be more beautiful than to watch the ever-varying changes of the great ethereal kaleidoscope, or anything more impressively grand as conveying the lesson of how very little we know of the economic phenomena of the universe. The point at which the great body of light converged was from eight to ten degrees eastward or south-eastward of the Polar Star. The constellation of Ursa Major (non-scientifically known as The Plough), being at present in the zenith, constituted a very attractive feature; and at one moment a vivid ray of silver-light shot from the two leading stars, commonly called 'The Pointers,' to the Polar Star, tracing a line with sharply-defined accuracy. So well-marked was the colouring at intervals that portions of the heavens displayed the precise aspect which is seen about the same hour in the region of sunset, on very warm nights in June or July. Now there was a golden sky, which would softly dissolve into a canopy of silver, passing thence into ruby, purple, dark blue, and every conceivable shade; while occasionally the fleecy, undulating vibrations of the streamers would exhibit an interlaced network of diffused light, the contemplation of which was a spectacle as sublime as it is rare."

Sir,—The splendid display of the Aurora Borealis, respecting which letters have appeared in the *Times* and various provincial newspapers, was also observed from Hull on the night of Thursday the 13th inst.

I first saw streamers in the north-east about 9.15, and immediately afterwards the auroral arch, extending from north-east to north-west.

At 10.45 beautiful masses of crimson light appeared simultaneously in the east and west, being brightest in the west. At the same time corruscations of white light appeared over the whole northern heavens, all converging towards a point in the constellation Bootes, near the star Epsilon.

Soon after, the southern portion of this constellation was occupied by patches of scintillating crimson light, and the northern part by similar patches of white light, the two colours being divided by a line of blue sky.

As 11 o'clock was striking, the heavens from east to west, and to about 30 degrees south of the zenith, were covered with red or crimson auroral light, whilst in the north the arch was sending forth faint but beautiful streams of tremulous rays.

About this time the planet Mars, then in the west, was enveloped in crimson aurora. The phenomena continued until 11.30, after which the sky became clear, and almost free from streamers. The northern arch, however, again re-formed after 12.

Having witnessed and made notes at the time of the brilliant aurora, witnessed over most parts of England on the night of Sunday the 24th October 1847, I may add, I do not think the one of last Thursday was equal to it.

The occultation of Regulus, and almost contemporary conjunction of the Moon and the planet Mars, on the evening of the 18th, could not be observed from Hull, on account of the very unfavourable weather, much rain having fallen during the last three days.

I remain, dear Sir, yours truly,

Hull: May 19, 1869. WILLIAM LAWTON.

BRIGHT OBJECTS PASSING THE SUN.

Sir,—When looking at Venus, just after noon on the 2nd of May, I saw a remarkable phenomenon. I call it a brilliant shower of meteors. These meteors, as I term them, were exactly like planetary bodies as seen in the telescope, varying in size and brightness, and some of them appearing larger than Jupiter. Many of the larger ones were fringed on one side; the fringe appearing somewhat bluish. They shot across the field of view for about an hour and twenty minutes in an almost continuous stream, 15 or 20 being seen together, and were still passing when I left the spectacle, which I could no longer stay to witness. The time occupied by a single meteor traversing the field was probably half a second. Their course was westward. I did not observe the way of the wind.

I find the subject mentioned in the *Astronomical Register* (vol. 5, pp. 157, 179, &c.,) where the meteors are said to be the seeds of dandelion highly magnified. But does not the date disprove such a supposition? A few specimens of dandelion in seed may perhaps be seen at the beginning of

May, but I have only seen one plant this year bearing seed. The thistle and the poppy flower in June. I cannot help think this supposition altogether fanciful. Would the seeds of the dandelion or thistle, respectively, of the form of a parachute and a shuttlecock, by any magnifying power or process, present clear, round, planetary discs; and would they move in a straight line rapidly across the field of view?

An unscientific person to whom I showed the sight while it was going on, when told that the meteors were supposed to be floating seeds, said that they were just like shooting stars in the winter. Is not this a commonsense view of the matter? Why should they not be meteors of periodic recurrence, like the November ones?

Earls Barton, Northampton: D. T. K.
May 18.

SOLAR PHENOMENON.

Sir,—Shortly after six o'clock last evening a—to me—rather curious phenomenon occurred here, the following short description of which, perhaps, you will kindly insert in the next number of the *Register*, if you think it of sufficient interest.

The disc of the sun at the hour named was covered by thin clouds, but not sufficiently to obscure it, and, what I think very singular, spanned at a few degrees distant by a faint bow, composed of the prismatic colours. The wind had been almost due east all day, and I should imagine, from the plentiful rainfall of to-day, that the atmosphere was at the time surcharged with moisture.

Yours faithfully,
Southsea: May 3. R. F.

OCCULTATION OF REGULUS, AND CONJUNCTION OF MARS WITH THE MOON.

Sir,—I have no doubt that many of your readers, like myself, thought of carefully observing the occultation of Regulus and the conjunction of Mars with the Moon on the 18th inst. I was, however, as they must have been, rather surprised on finding that the star passed the Moon without losing any appreciable amount of its brilliancy, and that the planet Mars was at least 34 minutes of arc distant from our satellite at the time of conjunction, instead of only 2 minutes, as stated in the *Nautical Almanac*. The Moon was frequently hid by dark clouds, but I was enabled to make observations at 9.58, 10.0, to 10.8, 10.13, and very frequently afterwards. The disappearance of the star should have taken place at 10.1 P.M., and at this time it certainly was very near to the southern edge of the Moon's disc, but entirely escaped occultation.

I trust that this communication will be in time for insertion in the June *Register*. I am, Sir, yours truly,
WILLIAM F. DENNING.

Ashley Road, Bristol: May 19, 1869.

Sir,—I hope you had a good view of the occultation of Regulus last evening. *Here*, the Moon only made a near appulse to the star, which at about 10h. G. M. T. was in a line with the terminator. After this, clouds prevented further observation. I had made no calculation, but thought it likely there would be no occultation; the neighbourhood of Mars, however, made up a pretty group.

I am, Sir, yours, &c.,
Tynemouth: May 19, 1869. GEORGE J. WALKER.

WINNECKE'S COMET.

Sir,—The following Ephemeris of this comet by M. Linsser of Pulkowa will be useful to some of your readers:—

	R.A.		Decl.		Brilliancy.
1869.	h.	m.	°	′	
June 1	9	33·3	+36	52	6.0
3	9	30·7	36	52	6·9
5	9	27·5	36	52	
7	9	23·8	36	52	8·5
9	9	19·2	36	53	
11	9	13·8	36	53	10·6
13	9	7·4	36	52	
15	8	59·8	36	49	
17	8	50·7	36	44	
19	8	40·0	36	34	
21	8	27·7	36	17	
23	8	13·6	35	51	
25	7	57·7	35	14	
27	7	40·4	34	21	

So long a continuance of motion in a comet parallel to the equator, is, I think, unique. The comet is in perihelion on June 29, and in perigee some time later.

Your obedient servant,

May 18, 1869. G. F. CHAMBERS.

Sir, In Professor Hind's letter to *The Times* of the 17th instant he states that, in Winnecke's Periodical Comet, "the *strongest condensation* of light *is not central.*" In my new theories of the universe I have explained the *cause* of this eccentric position of the strongest condensation of light, namely—all the celestial bodies move forward in space with that *portion* of each which is *heaviest*, foremost, just as a wooden ball, for instance, projected from a cannon, with a piece of iron inserted on one side, would travel; with the heaviest portion foremost.

Yours truly,

May 19, 1869. J. BEDFORD, PH.D.

THE NON-ROTATION THEORY.

Sir,—I am sorry to see this controversy cropping up again, as I thought the full discussion it received in the *Register* some time ago had cleared it up.

There is, however, evidently a lingering disbelief in lunar rotation, and although, like a recent correspondent to the *Register*, I don't expect to settle the question, the following remarks are submitted, if you can find space for them.

Grant, for the sake of argument, the moon has *no proper rotation about an axis within herself*, but is simply twisted round a centre, near the earth, by virtue of her revolutionary motion.

Then, *suppose that the moon had a rotation of the ordinary kind*, would the phenomenon presented be different from what it now is?

One would certainly suppose there must be some difference, otherwise we have two different causes producing the same effects.

If an additional moon were assigned to the earth, and made to rotate, say in 40 days, but without any other motion, we should then evidently see that it was a rotating body, turning about an axis within itself, and about its own centre ; the entire movement having reference only to its own mass, and presenting its entire surface to us in the period of forty days.

Now, let this rotary globe be urged forward into an orbit under similar conditions to those of the moon, but completing its revolution in forty days to the minutest fraction of a second. The result of the two motions will be, if I understand it, apparently to arrest the rotation altogether, and present only one and the same side to the earth precisely as the moon now does.

If it should be admitted that no difference could be perceived, and that, to all appearance, both bodies were moving in the same way, is it not a fair inference that no difference in the motions really exists, but that both are precisely similar ?

Illustrations, such as a ball on the leg of a revolving compass, may seem at first to favour non-rotation, for how can the ball turn when fast to an iron spindle ? The ball, in that case, becomes only a portion of the rotary system.

Let the ball be enlarged to include the other leg, and extend as far beyond, to form, in fact, a ball whose axis is the leg upon which the rotation is performed, and then the delusion vanishes.

In like manner, if the moon were embedded in a globe as large as the diameter of her orbit, everyone would then admit her to be rotating with the common mass, in the common period, and twenty other bodies so embedded would do the same; but any such masses detached from the rest would evidently rotate and revolve in the same time.

Yours faithfully,

Birmingham : April 10, 1869. FREDERICK BIRD.

LIST OF SUBSCRIBERS—Name received since our last number.

Tripp, Jas. S. Esq., Copthall, Twickenham.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To December 1868.
Williams, H.

To June 1869.
Blacklock, A.
Denning, W. F.
Elliott, R.
Linwood, Rev. W.

To August 1869.
Reside, J. P.
Tripp, J. S.

To September 1869.
Petty, T.

To December 1869.
Crowe, Rev. R.
Squire, H.

To December 1870.
Banks, R. R.

May 25, 1869. Subscriptions after this date in our next.

NOTICES TO CORRESPONDENTS.

Many communications are deferred from want of space.

We have received from Mr. Lockyer copies of his papers :—1st, "Spectroscopic Observations of the Sun, No. 3 ;" and 2nd, "Preliminary Note on Researches on Gaseous Spectra."

From Professor P. Smyth we have the "Report to the Board of Visitors of the Royal Observatory, Edinburgh, 20th April 1869."

From Mr. H. Perigal, "Drawings of Ellipsic Spirals."

ASTRONOMICAL OCCURRENCES FOR JUNE 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Tues	1	 19 21	Sidereal Time at Mean Noon, 4 40 1·6 ☾ Moon's Last Quarter			Saturn — 12 9·7
Wed	2		Meridian passage of the Sun, 2m. 19s. before Mean Noon			12 5·4
Thur	3			3rd Sh. I. 2nd Sh. I. 1st Ec. D.	14 32 15 8 15 32 44	12 1·2
Fri	4			1st Sh. E. „ Tr. E.	14 57 15 45	11 56·9
Sat	5					11 52·7
Sun	6	10 44	Conjunction of Moon and Jupiter, 4° 17′ N.			11 48·5
Mon	7					11 44·2
Tues	8					11 40·0
Wed	9	15 52	● New Moon			11 35·7
Thur	10	8 34	Conjunction of Moon and Venus, 3° 55′ N.			11 31·5
Fri	11	1 32 15 37	Conjunction of Moon and Mercury, 1° 44′ N. Conjunction of Moon and Uranus, 2° 23′ N.	1st Sh. I. „ Tr. I.	14 39 15 33	11 27·2
Sat	12			1st Oc. R.	15 1	11 23·0
Sun	13					11 18·8
Mon	14		Illuminated portion of disk of Venus, = 0·985 of Mars, = 0·895	3rd Oc. R.	14 30	Moon — 4 5·4
Tues	15	12 58 16 45	Conjunction of Moon and Mars, 1° 58′ S. Conjunction of Mars and χ Leonis (4m 1) E.			4 59·6

DATE		h. m.	Principal Occurrences	Jupiter's Satellites	h. m. s.	Meridian Passage h. m. Moon
Wed	16	14 15	Sidereal Time at Mean Noon, 5 39 9·9 ☽ Moon's First Quarter			5 52·0
Thur	17	2 22	Conjunction of Venus and Mercury, 3° 24′ S.			6 43·3
Fri	18	10 55 11 36	Occultation of 80 Virginis (6) Reappearance of ditto			7 34·0
Sat	19		Meridian Passage of the Sun, 1m. 1s. after Mean Noon	**1st** Ec. D. **2nd** Ec. D.	13 49 4 15 3 14	8 24·9
Sun	20		Saturn's Ring: Major Axis=41″·5 Minor Axis=18″·5	**1st** Tr. E.	14 16	9 16·8
Mon	21	15 8	Conjunction of Mars and σ Leonis (8m.·8) E.	**2nd** Tr. E. **3rd** Ec. R.	14 3 14 32 50	10 9·8
Tues	22	1 13	Conjunction of Moon and Saturn, 2° 37′ S.			11 3·8
Wed	23	10 53 11 56 13 39	Occultation of μ^1 Sagittarii (4) Reappearance of ditto ○ Full Moon			11 58·1
Thur	24	9 46 10 33 11 15	Inferior conjunction of Mercury Near approach of Moon to B.A.C. 6539 (6) Near approach of Moon to π Sagittarii (3)			Saturn — 10 32·2
Fri	25	2 16	Conjunction of Uranus and Venus, 0° 42′ N.			10 28·0
Sat	26			**1st** Ec. D.	15 42 53	10 23·8
Sun	27			**1st** Tr. I. „ Sh. E.	14 3 15 9	10 19·6
Mon	28			**1st** Oc. R. **2nd** Tr. I. „ Sh. E.	13 28 14 27 14 30	10 15·4
Tues	29					10 11·2
Wed	30					10 7·0

THE PLANETS FOR JUNE.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	6 28 35	+23 54	9″·8	1 32·5
	20th	6 24 44	20 2½	12″·0	0 29·7
Venus	5th	5 25 34	+23 38	9″·6	0 29·7
	20th	6 46 14	23 59	9″·8	0 51·2
Mars	5th	10 34 53	+10 12½	7″·8	5 38·1
	20th	11 2 51	7 3½	7″·2	5 7·1
Saturn	5th	16 50 26	−20 45	16″·6	11 52·7
	20th	16 45 50	20 38½	16″·6	10 49·1

THE LUNAR CRATER LINNÉ.

In "The Mare Serenitatis, its Craterology and Principal Features," by Mr. Birt, the following passages occur:—

"*v*. This spot, which has been considered as representing Linné at the epoch of Schröter's drawing in 1788, is not found in that of March 15, 1796. The fact that Linné lies in the same line as Bessel and Plinius is conclusive that it could not have been Linné. On the other hand, the dark spot *g* falls exactly in the line; and as there is clear evidence from Rutherford's photogram that Bessel is properly placed in Schr.'s drawing with regard to Sulp. Gallus, 1 $A\tau^{3}$ and 1 $A\psi^{3}$, and also as Rutherford's photogram contains a spot which is nearly similarly situated with respect to Bessel and Linné as Schr.'s *v* is to his *q* and *g*, it is not unlikely that this spot, 1 $A\psi^{16}$, is the *v* of Schr."

"This spot lies exactly in the line joining Linné, 1 $A\psi^{3}$ and 1 $A\tau^{3}$. Schr.'s *v* is a little E. of this line in his drawing. J. & W. have a spot a little W. of it. Whether Schr.'s and J. & W.'s are the same it is difficult to say in the absence of recent observations."

"Schr. gives in the drawing of 1788 a ridge which he has not lettered, extending between his dark spot *g* and his crater *k*, which is most distinctly traceable on Rutherford's photogram, commencing at Linné, passing 1 $E\theta^{1}$, and gradually curving round to 1 $E\kappa^{1}$. This is another item of evidence of Linné being represented by Schr.'s dark spot *g*."

ADAMS PRIZE ESSAY.—Is the Adams Prize Essay on the Calculation of a Comet's Orbit yet published, and at what price?

T. P.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 79. JULY. 1869.

ROYAL ASTRONOMICAL SOCIETY.

Session 1868–9.

Eighth Meeting, June 11, 1869.

Admiral Manners, *President*, in the Chair.

Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Minutes of the last meeting were read and confirmed.

Twenty-eight presents were announced, and attention was particularly directed to a work by Mr. Penrose, dedicated to the President, *On the Prediction of Occultations and Eclipses, by a graphic Method*; to a set of cards in a portable case, of formulæ for calculating problems in nautical astronomy, by Admiral Shadwell; and to a set of optical diagrams purchased with the Turnor Fund.

W. W. Magee, Esq., was balloted for and duly elected a Fellow of the Society.

The following papers were announced and partly read:

Occultations of Stars by the Moon: by Mr. Joynson.

The author, in giving the times of these phenomena as to Regulus and some other stars, remarked that he feared his former notice of the difference between the observed times and those in the *Nautical Almanac* had given Mr. Plummer a great deal of trouble. He could only say by way of apology, if any such were necessary, that he had thought at the time that the difference was really greater than it ought to be, and he was glad to find that, with one exception, this was not the case.

Mr. Penrose said that the book he had presented showed he was much interested in the subject. He might, therefore, observe that the greatest discrepancy he had ever found between the observations and predictions was 1m. 5s.

Capt. Noble observed that this was about the result of his experience, which was rather an extensive one.

Note on the Transit of Venus in 1874: by Mr. Hind.

The author's results of the most careful calculations of the times and other elements of the transits of 1874 and 1882, computed from Le Verrier's Tables (of the accuracy of which there is no doubt), having appeared in the *Comptes Rendus*, M. Puiseux, in a subsequent paper, has given different elements for the transit of 1874. Mr. Hind has not much faith in re-examinations, but Mr. Plummer has taken the trouble to go over the figures, and finds that it is M. Puiseux who makes the error as to the contacts.

The President: This is a subject of primary importance, and we are much obliged to Mr. Hind for taking every means to prevent mistake or failure.

On the Numbers engraved on Scientific Instruments: by Colonel Strange.

This was an oral communication by the author, who said that he had some hesitation in troubling the Society with a matter of subordinate interest, but better judges than himself thought it desirable. The engraved numbers referred to were one of the difficulties of observing, and such difficulties were numerous enough without addition. To enumerate some:—There was, first, the necessity of a correct theory; then that the observations should be made at the right time; that the weather should be fine; that the instrument should be well contrived; the observer well trained, and in good bodily health. To these, at present, was added the difficulty of reading the figures on the instrument. He was not speaking in the interest of gentlemen who, for their own pleasure, take an observation of a star here and the moon there, but of the professional observer, who has to go through a routine of observations. For example, in India it was a regular task to observe three angles every night, which involved 80 observations, at each of which 5 micrometers had to be read off; the weariness of which might be understood, and how desirable it was to lessen the labour and difficulty of so doing. Such an establishment as the Royal Observatory at Greenwich was another case in point, and the experience there was the same. The speaker's attention had been directed to this subject 17 years ago, when, being in India, he had to read off a theodolite by Troughton, divided on brass, and the figures small and dingy. He made a new silver rim for the instrument, but being unable to engrave it or get a workman in the country he was surveying, he devised a mechanism for the purpose, consisting of a cutting-tool, attached by an universal joint to a lathe, and connected with the short arm of a lever, the long arm of which was carried over large cut-out models of figures; and the work being placed under the tool of the short arm, the figures were engraved of a reduced size. Nine years ago Col. Strange came home, after 26 years' absence, and made known his views to instrument-makers here and abroad, but the matter was not taken up. One maker commenced a machine for the engraving, but it was not finished to this day. At last, the late Mr. Cooke, who was always on the look-out for improvements, made a machine for the purpose, which, by the permission of his sons, was exhibited to the meeting, and other opticians were now making them as well. It was desirable to have the figures uniform in appearance; the speaker had therefore made a set of figures, which were exhibited, and also procured photographs of them, which he would be happy to supply to anyone wishing to have a copy. It would be seen that he had studied visibility chiefly, and he would run over the principal points. Little need be said about the 0 and 1. In 2 the curve was as open as possible, to avoid confusion, the form somewhat compressed and slightly hooked. With 3 the great difficulty is to avoid confusion with 8; this is effected by having a flat top. 4 required no particular remark. 5, as compared with others, had the lower part wider and flatter, to show as much white space as possible. 6 was an ellipse, with the loop much smaller than usual. About 7 and 8 he had little to say. 9 was the 6 inverted. The thickness was one-tenth of the height. The machine which cuts the figures is substantially a pentagraph, very free from shake. A tracer is passed over the model figures, while at the diminishing point over the instrument to be engraved, instead of a pencil a drill is set into rapid rotation by a fly-wheel and treadle, and this engraves the metal to any required depth. It would be shown in action after the meeting. The work is better done than by hand, which has been tested by employing chronometer-dial engravers, but the machine is incomparably greater in accuracy. Lest it might be thought the speaker talked too slightingly of the figures now in general use, he had procured some specimens of the figures used on the animals at the Horse Show, which were perfectly horrible, it being impossible for spectators to distinguish between 3 and 8. The tickets at the Royal Academy were quite as bad, and those in the Library of the Royal Society, if possible, worse. If he (Colonel Strange) could help to remedy this state of things, he would be very glad. The work could be more cheaply executed and performed by any mechanic usually found in workshops. The whole of the figures on a theodolite exhibited could be engraved in an hour. This was sufficient to prove the saving. Buyers of instruments should, therefore, insist on their being thus engraved, and the makers should adopt the suggestion.

Mr. Carrington: I object to your 6. It should go straight up.

Mr. Stone thought so too, but looked upon the present communication as one of great practical importance. In work like that carried on at Greenwich, where observations have to be continued for hours together, and under great strain and weariness, the absence of the possibility of mistaking figures is most desirable. He had investigated the number of such mistakes in reading which were made, and found 1 in 200 observations. He thought this a large proportion, but, perhaps, it was not more than should be expected, and nearly all of them were traced to confusion among the figures 3, 5, and 8. Another cause of error was confusion between the 10 and 100. The heads of the micrometer screws at Greenwich are much better engraved than is usual; but every improvement should be encouraged.

Professor Cayley: It would be better to use an arbitrary sign, such as H for the hundred.

Colonel Strange: It is of no use at all, and may be omitted.

Mr. Browning: It is difficult to get workmen to do anything twice alike. They will vary the pattern, and cut deeper or lighter. I shall adopt such a machine, and save myself an enormous amount of trouble and vexation.

Mr. Babbage: One rule should never be violated. The centre of every figure should be at an equal distance from the centre of the next. This is not always observed in Colonel Strange's pattern. I have tried the experiment of reading figures by all sorts of lights, and find simplicity the great element.

Captain Noble: I think Colonel Strange should have brought with him some instrument engraved in the old way, for comparison. Among the superb collection of instruments under his charge at Lambeth, I saw one which looked as if the figures had been cut with a cold chisel.

Mr. Pritchard: I should like one thing explained. An instrument I have is so slightly engraved that it is not so legible as another in which the figures, though worse in shape, are deeper. I can't say much for the beauty of the latter, but in time the other will have the figures rubbed out. Could not a compromise be made, and the figures of the new form cut something like the depth of the old ones?

Colonel Strange: I don't like to answer for what I have not seen; but the machine does not merely scratch, but actually removes a part of the metal. The figures can be cut to any depth up to the one-tenth of an inch. Some, in the instrument shown, are quite evident, though they might at first be overlooked.

Mr. Pritchard: I am not speaking at all in opposition to the plan, which I greatly admire; but if the depth depends on the will of the operator, it should be impressed on him to give sufficient depth.

The President: The 6 on the instrument is not the same as your figures on the board.

Colonel Strange: The model figures were cast at Mr. Cooke's, but the men did not exactly follow my design.

Mr. Pritchard: Were the letters of the names (on the theodolite) cut with the same machine?

Colonel Strange: Yes; they are just as cut.

Dr. Mann: I think the different appearance results from their being filled in, and showing black on a light ground.

Mr. Browning: They are filled with black wax.

Mr. Denison, in the interest of readers of books, called attention to a cognate subject, viz. the difficulty met with as to figures of reference in engravings; they are generally so small and faint. For example, Mr. De la Rue's pamphlet on the Solar Eclipse has figures in the plates which, although not bad, are very trying to make out. For himself, he very much preferred the long-tailed figures, which were very easily distinguished; but, doubtless, Colonel Strange had good reasons for giving them up.

The President: We are exceedingly indebted to Colonel Strange for having taken so much trouble to settle the best form of figures. Personally, I regret losing the long tails, but nothing can exceed the beauty of the figures on the instrument before us.

Colonel Strange: If not tiring the meeting, I have another incidental point to bring forward, namely, the method of illuminating the verniers of instruments. All sorts of plans have been used. One system had pieces of ground glass, another tubes of ivory. I have often carried a silver spoon to reflect light on the vernier, which answered very well, but there ought to be some certain plan. The light should fall in the direction the observer is looking, and not obliquely, so as to light the furrow on one side. My first plan was to place between the 2 lenses of the reading-glass a diagonal silver plate with a hole in it. This reflected the light admitted through an aperture in the side of the microscope, but the hole contracted the field, and other objects as well as the circle were reflected. I now use a plate of glass which allows the whole field to be seen, and reflects sufficient light. A diagram is before you, and it will be seen that it is a Ramsden's eye-piece with the reflector added. At the side is a hole covered with glass to admit the light. This is reflected to the limb and then back to the eye. The result is very beautiful. The tube should have 2 distinct adjustments, one to get it at the proper distance from the instrument, and the other to turn it round so that the hole may receive the light. This plan will be useful to surveyors, but still more to nautical men, who complain of the difficulty of reading sextants, particularly at night. Another point I would wish to mention, and which is often neglected, is, the angle at which the reading-glass is placed. The axis should bisect the angle of the bevelled vernier.

Mr. Stone: A similar principle of illuminating the microscopes is employed in the transit circle at Greenwich, for reading the declinations.

The President enquired whether any additional weight would be thrown upon the instrument?

Colonel Strange: There would be no sensible addition.

Captain Toynbee could corroborate all that had been said as to the difficulty of reading sextants at night. The twisting and turning to get light on the limb was most troublesome, and many men do not take such observations, because they say they cannot see. This invention was just the right thing.

On the Distribution of Nebulæ in Space: by Mr. R. A. Proctor.

Mr. Proctor exhibited a series of maps illustrative of the distribution of nebulæ over the heavens. He remarked that the maps were formed from a table which Mr. Cleveland Abbé had brought two years ago before the Society. He said that it was important to notice that the maps exhibited precisely the same peculiarities as others which he had drawn on the same plan from a table prepared by Sir John Herschel, including a smaller number of nebulæ. He would mention why this was important. If the larger table had given results differing appreciably from those of the smaller, we should have reason to believe that a further increase in the number of observed nebulæ would give results differing yet again from these. But when it appeared that the discovery of more than 1,000 new nebulæ did not appreciably affect the results exhibited in such maps as those shown, it might reasonably be held that we are already in a position to theorise respecting the actual distribution of the nebulæ in space. Now, there were certain peculiarities in the maps, to which he would invite the attention of the meeting. First, there was the great zone, in which nebulæ were wanting, this zone coinciding in a remarkable manner with the Milky Way. This phenomenon had been noticed before, and had been held to indicate that the nebulæ are free from all association with the sidereal scheme. For himself, he must admit he thought the peculiarity taught quite another lesson. If the nebulæ really were, as was supposed, external universes, he could see no reason why their arrangement should exhibit any correspondence with the position of our sidereal system; a mere unit (according to that view) in the system of universes. He held that the arrangement must be taken to indicate a very close association between the nebulæ and the sidereal system. He next called attention to the peculiar streaminess observable in the nebular system. This was not so marked in the northern nebular cluster as in the southern. But even in the northern it was so remarkable that Sir W. Herschel was led to infer that there exists a zone of nebulæ at right angles to the zone of the Milky Way. Sir John Herschel, however, by completing the survey of the heavens, was able to show that the actual arrangement was (as had been already mentioned) a different one. In the southern heavens, the streamy formation of the nebular cluster was much more characteristic, however. Two very well-marked winding streams were to be noticed, and these were found to lead to those strange objects the Magellanic Clouds. Now, he confessed he thought the treatment these objects had received at the hands of astronomers was somewhat perverse. The mode in which they were usually dealt with was as follows: They are rich in stars, they are rich also in nebulæ; therefore they do not belong either to the sidereal or to the nebular system. He thought the more natural conclusion would be that they belong to *both* those systems. He looked upon the Magellanic Clouds as affording the most convincing evidence in favour of a view to which he had been led by other considerations—the view, namely, that nebulæ and stars form a single system. It was worthy of notice that Sir John Herschel had already pointed this out with his usual force and acumen, but had not apparently adopted the conclusions to which his reasoning had led him. But a yet more striking argument in favour of the association Mr. Proctor was endeavouring to establish lay in the fact that a stream of stars leads up to each of the Magellanic Clouds; these streams being those which the ancients had recognised in the River Eridanus and the stream from the water-can of Aquarius. When he found, further, that these streams were coincident in direction with the two marked nebular streams already mentioned, he felt justified in coming to the conclusion that the nebulæ really are closely associated with the stars. After some further comments on star-streams, Mr. Proctor concluded by expressing his belief that there is a close connection between the Galaxy and the stars which appear projected upon it, and that the nebular system is connected in precisely the same manner with the extra-Galactic stars. Stars, he also believed, appeared small on account of real smallness and not of their distance. External universes he thought were really very few in number, probably no more than 10 or 12; and the spiral nebulæ were most likely to be examples of such universes.

Professor Brayley: Would Mr. Proctor be kind enough to define the word "universe," and also to explain his use of the term "nebulæ," as he seems to draw no distinction between nebulæ and the clusters of various degrees of resolvability which are commonly included in lists of nebulæ.

Mr. Proctor: I have used the word "universe" in a sense which has commonly been assigned to it of late in works on astronomy—to signify the particular scheme or system of bodies of which our sun is a member. Thus nebulæ, looked upon as not associated with our system, would be spoken of as "external universes." The term is not strictly correct, I admit. By "nebulæ" I mean nebular objects which have never yet been resolved. The distinction is Mr. Cleveland Abbé's, who uses the term in that sense.

Professor Brayley: I must say I want a little more explanation of Mr. Proctor's views, and particularly why, after the discovery of Mr. Huggins that some of the nebulæ are masses of gas, he makes no difference between them and the other bodies which are shown not to be so constituted.

Mr. Proctor: My reason for not referring to Mr. Huggins' discoveries is simply this, that my views are not concerned with the nature of the nebulæ, but merely with their distribution over the heavens. I may notice, however, as a circumstance of some interest, that the irregular nebulæ (gaseous) are all in the neighbourhood of the Milky Way or upon it, while the planetary nebulæ, all of which are (I believe) gaseous also, affect the neighbourhood of that zone.

Mr. Huggins: The connection of irresolvable nebulæ with gaseous nebulæ seems to be very close. Of 60 or 70 nebulæ examined, a certain proportion showed bright lines, while the others gave a continuous spectrum. Lord Rosse kindly examined the observations made at Birr Castle of the same nebulæ, which include nearly all I observed, and the result was that it may be stated broadly that those marked as irresolvable give bright lines in the spectroscope, and those which gave a continuous spectrum were marked "resolved" or "probably resolvable." This result appears to be supported by the observations of Lieutenant Herschel in India.

Mr. Pritchard: This does not apply to their distribution.

Mr. Huggins: It may have been from considerations of convenience, but the bodies observed lie for the most part not far from the Milky Way.

Mr. Pritchard said it would take several evenings to discuss properly the subject which had been introduced by Mr. Proctor; namely, what is the true distribution of the heavenly bodies, the stars and nebulæ. Sir W. Herschel, whose marvellous researches he had lately had occasion to study, working with large telescopes, and taking all the stars visible with them, found that the distribution appeared to follow a law, viz. that the stars had a tendency towards one plane, and that in the opposite direction he found the nebulæ or external universes, as they have been termed. He (Sir W. H.) at first was of opinion that he might, by increasing his instrumental means, as it were, gauge the extent of the universe, but he subsequently found that he failed in this endeavour, and left the subject with the observation that the stars had a tendency to become dense in one direction, and that the nebulæ were mostly found in another. No doubt there was a tendency to an arrangement at right angles of the two classes of bodies, but the real question was, Do the nebulæ belong to our system? Sir W. Herschel spoke of them at first as unformed universes, but this afterwards became more than doubtful. The real *experimentum crucis* will be the finding of the parallax of a nebula, and until that is accomplished we must wait in uncertainty. Since he had been President the speaker had occupied himself with the careful examination of Sir W. Herschel's papers, which were not known as they deserved to be. He exhorted all to read them. They were simple in the extreme, and yet contained all that was known up to this time with respect to the distribution of the stars and nebulæ. Sir W. Herschel was not merely an observer and telescope-maker, but, as Struve and Arago agreed, he occupied the same position as to the stars that Newton did to the planets. Without reading Herschel it was no more possible to understand what Mr. Proctor had been talking about than if it were Chinese. Mr. Proctor was doing good service to science, but his views did not seem reconcilable with a curious statement of Sir W. Herschel's that, when he came to a perfectly dark space free from stars, he was accustomed to call to his sister Miss Caroline Herschel, who recorded his observations, to "prepare to write, as nebulæ were approaching;" and sure enough they came. Sir John Herschel confirms this fact, which did not look like a connection between the stars and nebulæ. The Herschels had no strict reason for their expectation of nebulæ in such places, but they did expect them, and believed they were looking through the interstices of our stellar system into space and there saw other exterior systems. These intensely black spaces (coal-sacks) in which no stars appeared, but nebulæ were expected and found, were most interesting. Why did not some of our army of amateur astronomers try to get the parallax of a nebulous object? It seemed to him also that the star-streams described by Mr. Proctor existed only in the maps, and could be made to twist where we pleased. These maps went down to the 6th magnitude or thereabouts, but we ought to begin with those of the 9th and 10th magnitude, where those maps left off. Such maps could in reality teach us nothing about the sidereal system. He suggested that Mr. Proctor should take D'Arrest's catalogue of nebulæ, and work upon this as Struve did on the stars. The maps were beautiful, but he would prefer all the brighter stars being omitted, except a few to point out the constellations, and taking all the small stars down to the limits of the telescope. As Mr. Pritchard understood Herschel's theory, that only began where the maps left off.

Mr. Proctor: Mr. Pritchard is rather begging the question, and has for a moment forgotten what my views are. Of course, if we adopt the view that the stars are distributed in space in the manner assumed by Sir W. Herschel, we could learn nothing of the sidereal system by considering only objects included in a space which we should then have to look upon as a mere speck in the sidereal system. But the opinion I am endeavouring to uphold is that the assumption of Sir W. Herschel is inexact, and that the lucid stars are connected with the furthest. The streams of stars may be dispensed with, but some that I have mentioned are very evident, and the smaller stars run into the same streams. The chances are against this if they are so far off. The fact noticed by Mr. Pritchard, that nebulæ are common where stars are wanting, seems to me to strengthen my case. If we are really to look on the intensely black spaces in the skies as the "spy-holes" of our system, and the nebulæ as far beyond, how can we account for the latter being placed so exactly opposite these spying holes? Is it that Mr. Pritchard thinks we cannot see them elsewhere because of the stars?

Mr. Pritchard: Yes.

Mr. Proctor: But why not? If the stars were so closely packed as to prevent our seeing out beyond them, the sky ought to shine with light as bright as sunlight. Is not this the case? Distance has no effect in diminishing the intrinsic brilliancy of an object, so that, if only the stars were packed close enough, they would give us a sky illuminated with light equal to the sun's in brilliancy. But putting that on one side, how is it that in the Magellanic Clouds, where stars are so crowded, the nebulæ are also so richly aggregated? In fact, I would be content to rest my case on the following considerations:—First, the existence of a stellar stream leading to a stellar cluster; next, the existence of a nebular stream leading to a nebular cluster; then the coincidence of these objects, stream for stream and cluster for cluster. I find this evidence irresistible. But when I consider that it is repeated, point by point, in the case of the lesser Magellanic Cloud, then I must say that I cannot understand how any one can fail to see its force. I should like to know how Mr. Pritchard would answer that part of my case?

Mr. Pritchard: I do not see my way to answer the point as to the Magellanic Cloud; but do one thing, and you prove your case. Take, not the stars which are found on maps, but the whole down to the 18th magnitude, and then, if you find streams of stars, you have gained a great point, and astronomers must enquire the explanation of it. Mr. Proctor has given three years to the subject and produced two maps; but this is a trifle compared with the time and labour Sir W. Herschel bestowed upon it.

The President: Mr. Proctor's maps are most valuable, as indicating the distribution and direction of the bodies in question. He would, I am sure, be the last to say he had exhausted the subject. We are much indebted to him for the personal investigation he has undertaken, and his neat and elegant maps.

Mr. Stone: I would ask whether Mr. Proctor has not misunderstood Mr. Pritchard's reference to the finding of nebulæ in the dark spaces. The diffused light elsewhere would sufficiently account for nebulæ being less readily seen than in these very black spots. Is not that the reason which the Herschels assign to the occurrence of nebulæ in such spaces?

Mr. Proctor: The effect of the diffused light must, of course, be carefully considered. I think, however, that the disproportion between the number of nebulæ in the Galactic zone and those outside that region is too great to be accounted for in this way. Besides, the consideration still leaves the aggregation of nebulæ within the Magellanic Clouds unaccounted for. In fact, it renders that phenomenon more difficult of explanation. There is also another circumstance which the explanation leaves unaccounted for. That is, the aggregation of star-clusters and *resolvable* nebulæ near the Milky Way. The strange circumstance that, as we leave the neighbourhood of the Milky Way, the nebulæ gradually become less and less resolvable, is, in fact, one of the strongest points of my case, but it is one which will require much time to present with its full force.

On the Nature of the Appearances on Sun-Spots called Bridges: by Professor Brayley.

At the last meeting the author suggested that the bridges on the spots described by Messrs. Bidder and Browning might be, and probably were, the faculæ such as were seen in Mr. De la Rue's photographs; and this opinion was supported by Mr. Huggins, who stated that the bridges were the brightest objects on the sun, exceeding the average brightness of the photosphere. Mr. B. since finds that, in three papers contributed by him to the *Companion to the British Almanack*, he had brought forward this view, and that in the paper of 1866 he had cited several passages from the writings of the Kew observers in support of his opinion. These passages were quoted, and stated to be in harmony with the author's opinions and those of Mr. Huggins. It must be understood that bridges of light only were referred to, and not bridges of penumbra connecting the sides of spots. From Mr. Browning's description of the penumbral bridges, it would appear they were compound ones. A spot seen by Mr. Howlett in 1865 was strictly conformable to this view. The spectrum of bright lines seen by Mr. Huggins over the umbra of a spot, and Mr. Lockyer's observations, corroborate it. Other points connected with the subject must be reserved for the next session, but the observations of Lockyer and Secchi prove faculæ and prominences to be identical.

Mr. Huggins: A remark of mine has been referred to by Professor Brayley as of more general application than I intended it. I said I had seen bridges exceeding the average brightness of the photosphere, but I did not state that this was always the case. The remark was made in reference to a particular spot. A second point is, that my observation of bright lines over a spot does not go to support the conclusion that faculæ and prominences are the same objects. At the same time that I saw the bright lines over the dark umbra, the bridges gave a distinct continuous spectrum. No doubt the bright lines of the prominences are always present on the solar spectrum; but the brightness of the photosphere overpowers them, and they therefore only tend to reduce the intensity of the Fraunhofer lines C and F; but where a spot removes the light of the photosphere we can then perceive the bright lines on any part of the sun's disk. Before the observations of the solar eclipse, I saw the lines C and F lessened in darkness on the umbra of a spot, and I have since seen them turned to bright ones. Where bridges or spots of light appear on the umbra, they give a continuous spectrum. I have received an interesting letter from Lieut. Herschel, in India, wherein he states that he has seen in the spectra of the prominences, besides C and F, a line near G, which may be hydrogen, another near C, and one between F and G.

On a Simple Form of Star Spectroscope: by Mr. Browning.

The author exhibited the small instrument and a large diagram of it. He said that, being desirous of making a star spectroscope adapted for ordinary telescopes, he had made many experiments before arriving at the present form, which in its results was equal to anything required of the kind. A cylindrical lens was placed in the line of rays from the object-glass of the telescope; they then fell on the jaws of the slit, which were shut and opened equally on both sides by an arrangement of eccentrics or cams. The image of the slit was received on a small achromatic lens, and the light dispersed by 5 direct-vision prisms, and passed to the eye of the observer through the sliding eyepiece. The slit must be adjusted till the best definition was obtained. The distance of the cylindrical lens, and the slit also, might require variation. The weight of the instrument was only 7 ounces, which would not overtax the driving-clock of an ordinary telescope.

Mr. Huggins: I would desire to join in thanking Mr. Browning for the very convenient form of spectroscope he has arranged. I have mounted and employed direct-vision prisms on the same plan, with the exception of the very pretty mechanical appliances for altering the jaws of the slit. When, however, it is not desired to compare the lines seen directly with the terrestrial elements, nothing can be better than to place a direct-vision prism behind an Huyghenian eye-piece. I would offer two suggestions in respect of Mr. Browning's instrument; one is, that the collimating lens should be of longer focus, not less than 3½ to 4 inches, and then the spectra would be seen much better. With a shorter focal length of the collimating lens, the jaws of the slit must be placed very close indeed. This is a spectroscope without an eye-piece, but I have found it best to supply one magnifying 4 times, for bright stars. Stars of the 1st and 2nd magnitudes would bear this power, and the lines of the nebulæ would stand a greater power still, as they would appear more separated, but not greatly fainter.

Mr. Browning: I am quite sure Mr. Huggins's first suggestion is a good one. I have got to 2½ inches, and feel that 4 inches will be better. I will also try the small eye-piece. My object has been to produce a spectroscope fit for an ordinary telescope.

The President enquired the price of the instrument.

Mr. Browning did not wish it to be thought that he used these meetings to advertise his instruments. He could hardly say what this spectroscope would cost, but it certainly would not exceed 4 guineas.

Mr. Huggins wished to correct one remark he had made. It was not a simple eye-piece that he meant, but a small telescope to magnify the spectrum, which should be added to the instrument for bright stars. He had used the Galilean form with advantage where great shortness of the instrument was desired.

On the Theory of the Tides: by Mr. Ogilvy.

Note on Lambert's Theorem: by Professor Cayley.

The President stated that a Committee of the Presidents of the Scientific Societies had been formed to obtain the erection of a monument to Faraday, and, finding the Government would not take up the subject, it was intended to hold a public meeting in the course of this month at the Royal Institution, over which the Prince of Wales would preside, in order to bring the matter before the public. The day was not then fixed, but all scientific men should be made aware of the movement.

Mr. Pritchard enquired if Sir W. Herschel had a monument, and said the whole earth was the monument of such illustrious men.

The meeting then adjourned.

Note on last Report.—It was erroneously stated that Professor Newcombe was present at the meeting. Professor Newton, of Yale College, should have been named as accompanying Professor Lyman.

Erratum in former Report.—Page 99, line 18, for *Trois Rivière* read *Rivière du Loup*.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

REFLECTORS AND REFRACTORS.

Sir,—Every one will much regret that the late Rev. W. R. Dawes was not permitted to make that comparison of the optical capabilities of Reflectors and Refractors which he once contemplated. This would appear to be the most effectual method of ascertaining the true merits of the new reflector, when it is considered that refractors having, during a long period, been almost exclusively the construction used, *their* excellences have been completely established.

Since the introduction of some letters on this subject, I determined to endeavour to procure some results, with my reflector reduced to smaller apertures, which, together with prior observations, might be of service to some amateurs who may desire such information. A selection will be found below.

The instrument employed is a silvered-glass "With-Browning" alt-azimuth Newtonian of 9 inches clear aperture, and 77 inches focus, all the eye-pieces being achromatic, excepting the 87, which is a Kelner.

The optical functions of the telescope naturally fall into three main divisions. I. Dividing power. II. Illuminating, or light-grasping, power. III. Planetary definition. On each of these divisions, a few preliminary remarks seem requisite.

1. The term "divided" is only used when the components of a double star are seen quite circular, and separated by an intervening black space.

2. Under the second division a larger number of objects has been given, because the light-power of reflectors is at present known less definitely than their dividing power. In many cases the comparison has been partly made by a direct reference (in parentheses) to the results of several of our best observers with exquisite specimens of the refractor.

I am indebted to the kindness of Mr. Knott for diagrams of the multiple star σ Orionis, with his results with different apertures, on his Alvan-Clark refractor, some of which are inserted.

Some objects were observed with two or three different apertures, the diversity of visibility indicating their respective light-powers.

The magnitudes and distances of the *comites* only are given.

To get the *light* of a 4½-inch reflector, it was necessary to allow for the large size of the plane and setting. The aperture used was 4·8 inch, which, minus a 2-inch plane-and-cell, gives the same *exposed area* as a 4½-inch aperture, minus a plane &c., 1⅛ inch.

3. Planetary definition is so indefinitely conveyed by description, that I hope the objects mentioned under the two smaller apertures will be regarded as only indications of what they will show.

It may be noticed, too, that the 4½-inch aperture was under a disadvantage from the loss of light occasioned by so large a plane.

I.—*Dividing power.*

9-inches aperture.

γ^2 Androm. dist. 0″·58. Well divided with power 320, the dark space = ⅓ diam. of C. Contrasts of colours beautifully seen, but I thought B pale greenish-white, C blue as usual.

μ^2 Boötis. 0″·55. A dark—not quite black—line between the discs, with 212. Easily divided, with clear black space, with 320.

ζ Cancri (AB). 0″·6 +. Well divided with 320. Bird's double, near Procyon. 0″·6. Just divided with 212.

OΣ 175, near Castor. 0″·5. Clearly divided with 600, and colours seen—orange and blue.

δ Cygni. Easy in good air with 212.

6½-inches aperture.

Σ 749 Tauri. 0″·8. Just divided with 212. With 320 the black space = ½ either disc.

14 Lyncis. 0″·7. Nicely divided with 320. I thought B green. Very pretty object.

δ Cygni. Very fairly with 212.

4½-inches aperture.

ε Arietis (AB). 1″·1. Easily divided with 212.

η Coronæ. 1″. Easily divided with 212. (1869·25).

η Orionis. 1″. This fine test clearly divided, and the dusky purplish tint of B independently noticed, with 320.

ξ Boötis. 1″ (or less ?). Just divided, but very close (certainly closer than the preceding) with 320.

II.—*Illuminating power.*

9-inches aperture.

μ Androm. 16 mag. dusky. 49″. (Smyth: with 5·9 inch, only once seen after many times sought, with A hidden). Steadily visible with 320. With 8 inches pretty steadily.

σ Orionis. Besides the 10 members of this group, and one *n p*—2 faint stars, seen pretty steadily with 320 (Knott: with 7½ inch. Alvan Clark, by glimpses). One still fainter, by glimpses (Knott: not certainly made out).

M. 3 Can. Ven. Fully resolved, even at the centre, with 212.

M. 5 Libræ. Resolved with 320, even at the centre, but very compressed there. E. of Rosse's curved branches well seen, one especially almost concentric with the ball.

M. 13 Herculis. Fully resolved, and the E. of Rosse's dark lanes (discovered with 6 ft.) beautifully seen with 320. (*Reg.* Sep. 1868.)

M. 1 Tauri (the "Crab"). With many stars visible in the oval, with distinct glimpses of nebulous appendages.

M. 32 Androm. Resolved with 212 into a globular cluster, having rays or streamers. Very bright nucleus mottled.

M. 31 Androm. Both of Bond's canals very readily with 87, with many glittering points on them. The darkest about 1° long.

Plan. Neb. near M 46 Argus. With 87 annular, a star on its *s* side.

M. 27 Vulpec. With 87 there is nebulous light exterior to both lobes, but principally on the *n*. The fainter oval filling-up easily seen.

M. 57 Lyræ. With 212 nebulous borders, exterior to the brightest part of the annulus; the interior nearly filled with conspicuous light, but not equably. With 320, I saw two or three of the minute stars surrounding it, which the E. of Rosse found with his 3-feet speculum.

H IV. 45 Gemini. With 212 nebulosity very conspicuous, and the inner dark ring very fairly seen, chiefly on *s* side.

6½-inches aperture.

55 Androm. 16m. bluish: 25″. (Sm.: glimpsed with intense attention). Steadily visible with 212.

110 Herc. 16m. dusky: 55″. (Webb: 5½-inch, pretty steady). Easily with 212.

52 Ariet. 15m. blue: 5″. Glimpsed in very unsteady air, with 212.

P. 178 Delph. 16m. blue: 20″. (Sm.: by evanescent glimpses.) Steadily with 320.

δ Cancri. 15m. blue: 25″. (Sm.: only seen by glimpses.) Steadily and easily with 212.

η Coronæ. (Smyth's "very minute star, seen by glimpses"). Pretty steadily with 320.

θ′ Orionis. The 5th not difficult with 132. The 6th seen in tolerably steady air. I generally thought the 6th intrinsically brighter than the 5th.

μ Androm. *Comes* glimpsed without great difficulty with 320. (See under 9 ins.)

M. 27 Vulpec. (Sm.: the "double-headed shot" only.) 87 shows H's oval filling-up plainly.

M. 31 Androm. Bond's lanes. (Webb: one with much difficulty with 5½ inch). With 87 one easily, the other pretty readily.

4·8-inches aperture.

(For a 4½ inch, with 1½-inch plane).

P. XI. 111, Ursæ Maj. 13m., plum-coloured: 17″. (Webb missed with 3·7 inch.) Easily and steadily with 212.

ι Ursæ Maj. 13m. purple: 12″. Glimpsed with 212. Very dull for its size.

ε Lyræ—the *debilissima*, 13m. (Webb: glimpses of one, and suspicions of the other, with 3·7 inch). One easily, the other pretty steadily, with 212.

14 Monoc. 16m. (Σ 11·2): 10″. Glimpsed with 212.

15 Monoc. 15m.: 15″. (Webb: steadily with 5½ inch. One still smaller and more remote.) The first steadily, the smaller star by glimpses, though not very easily, with 212.

55 Androm. *Comes* glimpsed pretty readily with 212. (See under 6½ inches.)

δ Cancri. *Comes* glimpsed with 212. (See under 6½ inches.)

σ Orionis. 11 stars seen with 132. The same with 4½-inches ap. and 212. (Knott: one of these "glimpsed?" with 4 inches and 174). N.B. An ap. of 4½ inches with the large plane gives exactly the same exposed area as a 4-inch o. g.

M. 31 Androm. One lane traced pretty readily with 87. (See under 6½ inches.)

III.—*Planetary definition.*

9-inches aperture.

Linné. The small crater repeatedly seen with 212 and 320. Once the W. hill divided, and probably a faint spire of shade at the same time extending to the E. border of Linné.

Jupiter. The equatorial cloud belt has repeatedly been seen as a number of bright masses with fainter outlines. (*Reg.* Sep. 1868.)

Venus. The following features have been observed on her disc:—Faint cloudy patches, dark and bright specks and streaks, faint shady curved lines, an indented terminator, and blunted cusps. (*Reg.* June and Sept. 1868.)

6½-inches aperture.

Stadius. 12 or 15 of the minute craters in this enclosure readily seen (through cloud). Several of these also when more than two days in sunshine.

Jupiter, 1868, Dec. 23. A bright mass on the equatorial cloud belt, and a darkish speck on one of the S. dark streaks, easily.

Venus. The faint cloudy spots, and bright regions near the cusps, seen.

4½-inches aperture.

Copernicus. The S. part of the floor nearly covered with blocks—easily.
Jupiter. The numerous dark narrow streaks extending from the N. belts to the limb—very distinctly.
The features mentioned under 6½ inches were also pretty readily visible with this ap.

I have been specially desirous of obtaining reliable comparisons of the light of these reflectors, as compared with refractors. The only means I have for *direct* comparison is a refractor of 2·9-inches aperture, and 46-inches focus. I am in hope that the result may not be altogether valueless, although under the disadvantage of smallness of aperture. This instrument divides 52 Orionis, 1″·8 with 127; and shows the small stars a and G in σ Orionis (making it octuple), with 170, one only of which was visible to Mr. Knott with 2·74 inches and 174. I find eccentric openings on the reflector act perfectly: for 3 inches and smaller I use them, and so get a perfectly unobstructed opening. (1½ inch and 132 shows the companions to Polaris and Rigel; 2¼ inches and 212 the *comes* of Aldebaran, steadily.

I found, after several trials, that for a terrestrial test, white circles on a black ground were the best. These, varying from 1 inch to 0·1 inch in diameter, about 70 yards distant, gradually fading away as the darkness of evening came on, were observed for the first comparison.

I fitted one of the reflector's achromatic eye-pieces to the refractor, which produced a power of 130. The power on the reflector—with films of 16 months' standing—was 136.

These were the results :—

2 - inch refractor not quite so bright as 2¼-inch reflector.
2¾-inch „ a very little brighter than 3-in. „

The same night on a faint star, *p*, the 7m. star *s* of Polaris—which was almost immovable in the field—the o. g. being quite free from dew, with the same eye-pieces giving powers of 127 on the refractor, and 132 on the reflector, the results were these :—

2·9-inch refractor noticeably brighter than 3-inch reflector.
2·75-inch „ not quite so bright as 3-inch „

At the time, I concluded that 2·8-inch refractor was exactly equal to 3-inch reflector.

By previous trials I had found the white discs less visible with increased power, so that on *these* the *refractor* would have a little advantage from the lower power. On the *star* the *reflector* had probably a slight advantage, from the same fact operating contrarily. I think this will explain the small discrepancy between the results of the two methods.

I believe the mean result to be—

2·75-inch refractor = 3·0-inch reflector.

From this we may deduce the comparative light of instruments—taking a 2-inch plane for a 9-inch mirror, other sizes being in proportion—as follows :—

9-inch reflector = 8-inch refractor.
6½ „ „ = 5¾ „ „
4½ „ „ = 4 „ „

The conclusions I have myself come to as to the optical capabilities of my reflectors, are these :—

I. The *dividing power* on general pairs is fully equal, if not superior, to that of a refractor of the same aperture.

II. The *illuminating power* is equal to that of a refractor of 8-inches aperture.

III. The *definition of planetary features* is in all cases equal to that of an 8-inch refractor, and in some cases superior even to that of a 9-inch refractor, owing to the uncorrected colour of the latter. We are fully justified in believing that if the superlative refractors of Alvan Clark and Cooke were capable of showing markings on Venus, the superior eye of the late Mr. Dawes would have detected them. Mädler says he in Dorpat [9·6 in.], and Lamont in Munich [11·2 inches?], sought in vain for her spots. (*Reg.* Nov. 1868.)

Hoping that some observer possessing a large refractor will be induced to complete the comparison here only inadequately made, and so settle these questions definitively,

I am, Sir, yours truly,
Earith, Hunts: May 1, 1869. T. H. BUFFHAM.

ARTIFICIAL TRANSIT OF VENUS.

Sir,—In the Monthly Record of the proceedings of the Royal Astronomical Society, contained in the current number of the *Register*, I notice some discussion which took place upon the possibility of producing, artificially, a ligament similar to that observed at the conclusion of a transit of Mercury or Venus.

I beg to state that on the 26th of March last I arranged my telescope to observe the Sun, which was at that moment rising into view. It so happened that, directly in the line of vision, at a distance of about 50 yards, there was interposed the sharply-defined roof of a small house, the highest point of which lay directly in the Sun's path. The power I had in use at that moment (75) gave me a somewhat large field, so I was enabled to observe that as the Sun gradually rose above the point referred to, that part of the solar edge immediately occulted by that point did not rise above it as it should have done, but was bent down towards it in a very gradual manner. As the Sun rose higher, this wide dark contact became lengthened and less broad, till it assumed the exact appearance of a thin ligature connecting the point of the roof with the Sun's limb, that part of the ligament touching the solar edge being the broadest part. This phenomenon remained plainly visible till the upper edge of the Sun was 4¼ minutes of arc above the highest point of the roof, when it rapidly collapsed and disappeared.

Judging from this occurrence, I should say that artificial ligaments may be easily produced upon the solar limb. It would be a somewhat crude method to reproduce this phenomenon by the same means as those which accidentally enabled me to observe it; but, with your permission, I will describe a way in which it may be produced and studied with advantage. If, at some distance from the instrument, a black ball is suspended between two uprights, so as to be exactly between the observer and the Sun's point of rising, the whole phenomenon may be observed, during the apparent contact of the black ball with the solar limb.

The ball and uprights should also be moved to various distances, from the shortest to the longest available, in order to ascertain whether distance would in any way affect the duration of the phenomenon. By this means, those gentlemen who are preparing to observe the approaching transit of Venus may become acquainted with those appearances which may certainly be expected when that planet leaves the solar disc. After a time indeed, by comparing results obtained by using different-sized balls at various distances, the duration of these phenomena may even be calculated beforehand.

Care should invariably be taken to make due allowance for the state of the weather at the time of observation. As these appearances are due to the apparent enlargement of the Sun's disc, *misty* weather would increase its apparent size still further, and so prolong the duration of the phenomenon.

I have never tried the method spoken of by Mr. Penrose, viz. a strung bead in the eyepiece, but I should imagine that the results would be very unreliable, even supposing that it produced any ligament whatever.

I remain, Sir, yours faithfully,
Hoxton Street, N.: May 5, 1869. ALBERT P. HOLDEN.

CONSTRUCTION OF OBSERVATORIES.

Sir,—The following particulars of an observatory in which I use a telescope of rather more than 5-feet focal length, and the plan of which was suggested to me by an account of one in Mr. Simm's little book, "The Achromatic Telescope," may be useful to your correspondent "P." and others.

The *length* of the building runs E. and W. The walls are, from the level of the floor, of 4½-brickwork. The inside measurements are:—

Length . .	11ft. 8in.	End walls, high .	6ft. 9in.
Width . .	7 6	Side ,, ,, .	5 10

The difference of height in the end and side walls is accounted for by a slope of about 15 inches, which is carried up from the side wall-plates and the flat part of the roof. These slopes may be used, as found desirable, for the admission of light. In my own building, that on the N. side is boarded and covered with felt, that on the S. side is all glass. The interior is divided by a partition, half-boarded, half-curtain, 4ft. 6in. from the E. end, giving ample space for all that is wanted to be permanently under cover. The door, a ledge one, 2ft. wide, is in this part.

The roof is carried on two beams resting on the end walls, 4 × 3 inches, and 14ft. 6in. long; these project over the E. end, and should slope a little in *that* direction to carry off the rain. The roof over the part partitioned off is a fixture, the other portion slides back over it, travelling on 6 small flanged wheels, which run on two bars of ½-inch iron screwed down. The whole roof is covered with zinc nailed down over thin boarding, and *well* soldered at the joints and nail-heads. It is perfectly weatherproof, and the whole thing works admirably. Inside, the walls are covered with canvas strained on battens and papered. I do not recommend this; thin boarding would be better, at least for the lower half. This, with the exception of making the telescope division 6 inches or 1 foot *longer*, would be the only alteration I should make in another building.

Several small details, which it is not easy to explain in writing, need contrivance and attention; as *e.g.* the manner in which the sliding roof fits. The zinc must project all round beyond the framework, for one thing. Then, it must be so contrived that it secures itself by running on to iron pins at each end when it is pulled home. Neglecting this, I once had my roof carried off by a very violent gale and landed in my garden. Then the cords which work the roof should run over two pullies screwed side by side into the cross beam OVER THE PARTITION, both for handiness of management and to be out of the way when the top is open.

It is perhaps worth consideration whether the sliding roof might not be better in two parts, meeting in the middle. The advantage would be that you need then uncover no more than was necessary at the moment. I achieve this in a very effectual manner by means of a stout roller blind at the W. end, which works by a weight and two cords which run along the sides, and meet where the roof cords are, so that they are all together. I find this works with perfect ease, and I can thus cover up, if the night is chilly, as much of the open part as I wish by merely pulling the cord. I do not see any reason why this plan of observatory should not answer on a larger scale than mine if thought desirable. In fine weather there are decided advantages in it for common observers.

It is difficult to name the exact cost of putting up such a building. Mine cost me about 16*l.* It might be done for less, or more, according to the way it was set about, and the amount to which labour was dispensed with. I ought to say that mine, being raised 2½ feet from the ground, on 9-inch brickwork, cost therefore more in that item than it would otherwise have done.

Any further information I should be happy to afford to anyone desiring it.

May 8th. J. H. J.

THE SUPPOSED NEW PLANET VULCAN.

Sir,—In the second volume of Petit's "*Traité d'Astronomie pour les gens du Monde*," I find a notice of Coumbary's observation, of which the following is a translation:—

"In a letter from Constantinople addressed to M. Le Verrier and communicated by him to the Academy of Sciences of Paris on the 29th May 1865, M. Aristide Coumbary states, '*that on the 8th May 1865 he saw a small black speck detach itself from a group of spots situated near the eastern edge and towards the top of the solar disc, and disappear 48 minutes later, at the western edge of the disc.*'

"M. Coumbary adds, '*that at the moment of egress the little black body seemed to assume an oval shape, and to be separated in the middle, as if it consisted of two bodies very near to each other. He cannot, however, be sure that this appearance was not an illusion attributable to fatigued eye-sight.*'"

Other observations of supposed intra-Mercurial bodies are also referred to by M. Petit:

"Two small spots were seen on the sun, *round, black*, and *unequal in size*, by Gruithuisen on the 26th June 1819, and by Pastorff on the following dates—23rd October 1822, 24th and 25th July 1823, six times during the year 1834 (no dates given), 18th October 1836, 1st Nov. 1836, 16th Feb. 1837. In 1834 these spots were 3″ and 1″·25 in diameter, the smaller preceding and sometimes following the larger one, at an angular distance which did not exceed 1′·16″. In 1836 and 1837, arcs of 12, 6, and 14 minutes were passed over in 52, 54, and 30 minutes of time."

As I have not seen any account of M. Coumbary's observations elsewhere, I think the above extract will not be without interest to some of your readers.

I am, Sir, yours very truly,

Bedford: May 4, 1869. T. G. E. ELGER.

JUPITER'S SATELLITES.

Sir,—Your correspondent "C." thinks that Mr. Buffham and myself have deceived ourselves, in supposing that we have ever seen Jupiter's III. Sat. with the unassisted eye. Were my belief that I have done so grounded upon a solitary instance, I should suspect some optical illusion; but as I stated in your No. 62, page 46, I saw the III. Sat. frequently during the autumn of 1867, and on one occasion, separated for a moment the III. and IV., then very close together. The positions, right or left of the planet, were in every instance verified by a reference to the configurations in the *Nautical Almanack after* the observations, to avoid any *bias*.

"C." also objects to Mr. Buffham's "method;" but, as far as I recollect, I never saw the satellite without using my hands by way of tube, to exclude surrounding light, and also bringing the planet near to one side, by which the rays were cut off and the disc in some instances fairly defined.

At the same time I readily add, that I have tried the proposed test and cannot read the *figures* of the *N. A.* at more than 7-feet distance, and with an opera-glass 1½ aperture, power 4, at more than 15 feet with both eyes, or the *right alone*, and at 12 feet only with the left; the aid derived from the latter, when used with the right, being apparently only increase of brightness.

If the two eyes differ so much, and mine do also, in defining power, there may be possibly much greater difference in the power of seeing or not seeing than your correspondent supposes; and without attempting to explain the non-legibility of figures as proposed, with the ability to perceive minute points of light, I must still believe that I have seen the object in question.

I am, Sir, yours truly,

Ealing: May 15, 1869. WM. L. BANKS.

A NEW OBSERVING SOCIETY.

We have always great pleasure in directing the attention of our readers to any project which is likely to aid the spread of practical astronomy; and the Observing Society, of which the following is a prospectus, will doubtless, if energetically carried out, be of great service for this purpose. Many—if not all—who have at present joined it, are among our subscribers, and it will be seen that the observations are to be published in our pages. We can only add our cordial wishes for its success.

PROPOSED "OBSERVING" ASTRONOMICAL SOCIETY.—It is proposed to form a Society of gentlemen possessing astronomical instruments, for the purpose of securing concerted observation of interesting astronomical phenomena, and recording the results obtained. The mode of proceeding proposed is as follows:—The Secretary will forward, monthly, to each member, a list of the astronomical phenomena expected during the ensuing month. Those members who observe any, or all, of the phenomena will send in reports of the same to the Secretary by the 12th day of the following month. The Secretary will then select the most valuable and interesting observations from the reports he may receive, and have them published in the next number of the *Astronomical Register*. A slip from the *Register* containing the report will be sent to each member.

It is proposed that the following be the Officers of the Society:—*President*, the Rev. R. E. HOOPPELL, M.A., LL.D., F.R.A.S., Winterbottom Nautical College, South Shields; *Treasurer and Secretary*, WILLIAM F. DENNING, Esq., Ashley Road, Bristol; *Committee*: T. P. BARKAS, Esq., Grainger Street, Newcastle-on-Tyne; JAMES COOK, Esq., Ribbleton Lane, Preston; A. W. BLACKLOCK, Esq., Waterloo Place, Manchester; H. MICHELL WHITLEY, Esq., Penarth, Truro; A. P. HOLDEN, Esq., 107 Hoxton Street, London. The President and Treasurer and Secretary to be ex officio members of the Committee. It is likewise proposed that the subscription be payable yearly on the 15th of June; that the amount be Five Shillings for the first year; that in subsequent years it be, if possible, less; that all intending members who send in their subscriptions by the 1st of July of the present year be deemed actual members; that after the 1st of July a gentleman wishing to join the Society be recommended by a member, to whom he must be personally known, and through whom he must send his application. The Secretary will be happy to give any further information that may be desired. Subscriptions may be forwarded to him either by Post Office Order or in stamps.

ASTRONOMICAL OCCURRENCES FOR JULY 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Thur	1	 12 46	Sidereal Time at Mean Noon, 6 38 18·3 ☾ Moon's Last Quarter			Saturn — 10 2·8
Fri	2		Meridian passage of the Sun, 3m. 42s. after Mean Noon	3rd Tr. E.	13 30	9 58·6
Sat	3	14 31 15 13	Occultation of ζ^2 Ceti (4) Reappearance of ditto			9 54·5
Sun	4	6 0	Conjunction of Moon and Jupiter, 4° 19′ N.	1st Sh. I.	14 51	9 50·3
Mon	5			2nd Sh. I. 1st Oc. R.	14 44 15 27	9 46·1
Tues	6			1st Tr. E.	12 44	9 41·9
Wed	7	18 32	Conjunction of Moon and Mercury, 0° 56′ S.	2nd Oc. R.	14 23	9 37·8
Thur	8					9 33·6
Fri	9	1 38 2 47 11 57 21 12	● New Moon Conjunction of Moon and Uranus, 2° 13′ N. Conjunction of Uranus with the Sun Conjunction of Mars and β Virginis (1m·7) E.	3rd Sh. E. " Tr. I.	12 51 15 44	9 29·5
Sat	10	8 58	Conjunction of Moon and Venus, 1° 40′ N.			9 25·3
Sun	11		Saturn's Ring: Major Axis=40″ ·7 Minor Axis=18″ ·0		.	9 21·2
Mon	12			1st Ec. D.	13 58 49	9 17·0
Tues	13	19 39	Conjunction of Moon and Mars, 3° 46′ S	1st Tr. I. " Sh. E. " Tr. E.	12 30 13 26 14 42	9 12·9
Wed	14		Illuminated portion of disk of Venus, = 0·949 of Mars, = 0·907	2nd Ec. D. " Ec. R. " Oc. D.	12 13 44 14 29 35 14 48	Moon — 4 40·4
Thur	15	18 48	☽ Moon's First Quarter			5 31·7

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Fri	16	 17 18	Sidereal Time at Mean Noon, 7 37 26·7 Greatest westerly elongation of Mercury, 20° 16′	3rd Sh. I.	14 40	Moon — 6 22·4
Sat	17		Meridian Passage of the Sun, 5m. 50s. after Mean Noon			7 13·3
Sun	18	8 16 9 33	Occultation of 49 Libræ (5½) Reappearance of ditto			8 5·0
Mon	19	4 52	Conjunction of Moon and Saturn, 2° 50′ S.	1st Ec. D.	15 52 32	8 57·6
Tues	20			3rd Oc. R. 1st Sh. I. „ Tr. I. „ Sh. E.	11 53 13 8 14 27 15 20	9 50·8
Wed	21	12 4 13 21 14 20	Occultation of 33 Sagittarii (6) Reappearance of ditto Occultation, disappearance of ξ^2 Sagittarii (4)	1st Oc. R. 2nd Ec. D.	13 50 14 50 53	10 44·0
Thur	22					11 36·2
Fri	23	 1 54	Eclipse of the Sun, invisible at Greenwich ○ Full Moon	2nd Sh. E. „ Tr. I. „ Tr. E.	11 31 11 54 14 13	Saturn — 8 31·8
Sat	24					8 27·7
Sun	25	11 2 11 21	Occultation of 45 Aquarii (6) Reappearance of ditto			8 23·7
Mon	26	1 7 17 36 18 4	Conjunction of Mercury and δ Geminorum 0° 4′ N. Occultation of ψ^1 Aquarii (4½) Reappearance of ditto			8 19·6
Tues	27	7 8	Conjunction of Uranus and Mercury, 0° 25′ S.	3rd Oc. D. 1st Sh. I. 3rd Oc. R.	14 8 15 2 16 1	8 15·6
Wed	28			1st Ec. D. „ Oc. R.	12 14 39 15 45	8 11·5
Thur	29			1st Sh. E. „ Tr. E.	11 43 13 4	8 7·5
Fri	30			2nd Sh. I. „ Sh. E. „ Tr. I.	11 45 14 6 14 33	8 3·5
Sat	31	1 53 5 6 22 38	Conjunction of Venus and α Leonis (15m·5) W. ☾ Moon's Last Quarter Conjunction of Moon and Jupiter, 4° 14′ N.			7 59·4

THE PLANETS FOR JULY.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	5 56 16	+19 1	10″·0	22 58·5
	20th	6 39 14	21 42½	6″·8	22 42·3
Venus	5th	8 5 34	+21 42	10″·0	1 11·3
	20th	9 21 5	17 6½	10″·4	1 27·6
Mars	5th	11 32 35	+ 3 37½	6″·6	4 37·8
	20th	12 3 53	− 0 1½	6″·4	4 10·0
Jupiter	5th	2 50 24	+15 14	34″·2	19 53·1
	20th	2 59 54	15 53	35″·4	19 3·5
Saturn	5th	16 41 47	−20 33	16″·6	9 46·1
	20th	16 38 44	20 30	16″·2	8 44·1

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To December 1868.

Browning, J.

To June 1869.

Metcalf, Rev. W. R.

To September 1869.

Blacklock, A.
Buffham, T. H.
Cook, James.
Elger, T. G. E.
Forward, R.
Payne, R.

To December 1869.

Alsager, J.
Andrews, W.
Glover, E.
Gooch, Miss.
Jefferies, J.
Matthews, W.
Stothard, Dr.
Thomson, Prof.

To December 1870.

Finch, A.

June 21, 1869. Subscriptions after this date in our next.

NOTICES TO CORRESPONDENTS.

In consequence of the sudden illness of the Editor, the publication of the *Register* has been unavoidably delayed. Our readers, who will be sorry to hear of his indisposition, will, we are sure, pardon any errors which may have arisen from the absence of his final supervision.

ERRATUM. In our last number, p. 139, line 2, for "think" read "thinking."

We have received from Mr. Huggins copies of these papers:—"Note on the Heat of the Stars," and "Some Spectrum Observations of Comets," read before the Royal Society.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

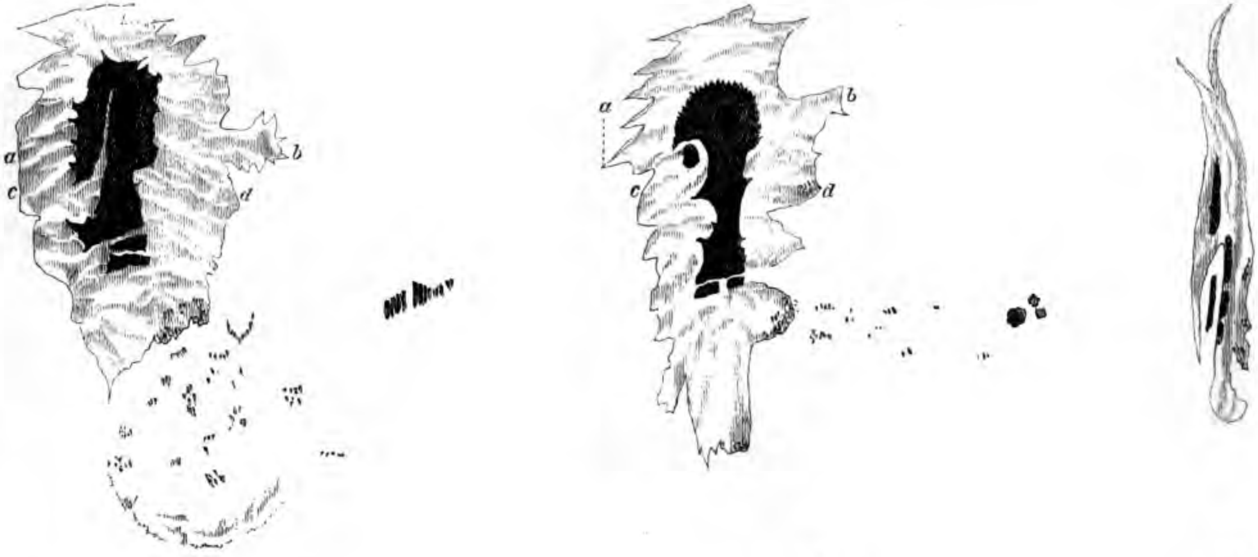


Fig. 4. Fig. 5. Fig. 6.

SUN SPOTS.

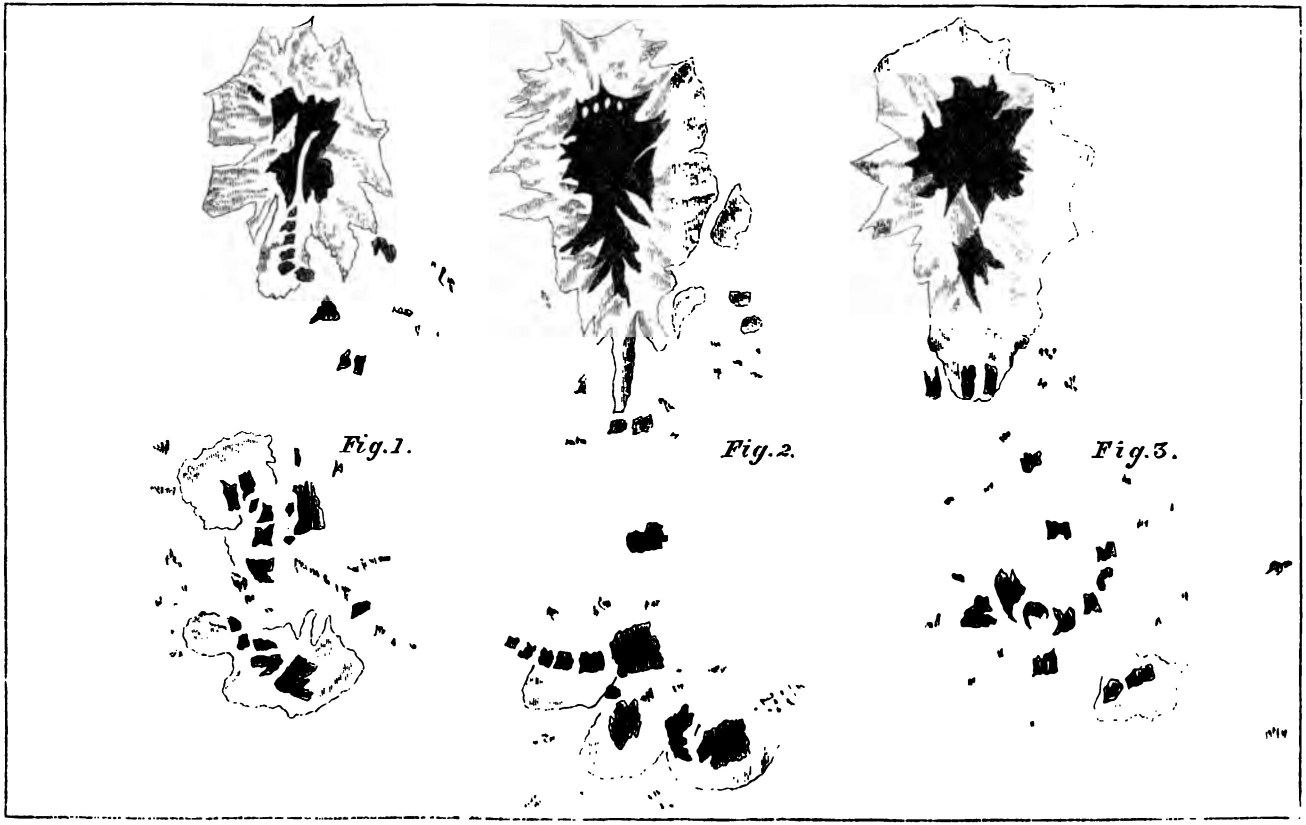


Fig.1.
Fig.2.
Fig.3.

SUN SPOTS.

The Astronomical Register.

No. 80. AUGUST. 1869.

CONTENTS.

PAGE
On Sun Spots 169
Correspondence:—
Zeta Cancri—Moon's Rotation—Theory of Comets—Construction of Observatories — Rotation — Spots on the Floor of Plato—Large Object Glasses — Pear-shaped Elongation . . . 171–180
Dr. Tyndall's Theory of Comets . 180
Mr. Penrose on Predictions of Occultations 181
Astronomical Occurrences for August 182
Planets for August 184
Miscellaneous Notices . . . 184
PAGE
Additional Correspondence:—
Bright Bodies on the Sun—The Satellites of Jupiter—Spectrum of Aurora—Planetary Transit; Aurora 185, 186
Total Solar Eclipse of 1868 . . 186
The Planets for September . . 187
Occurrences for September . . 188
Royal Observatory, Greenwich. . 190
The Use of High Powers with Reflectors 191
Lunar Monograms 192
Notices, &c. 192

SUN SPOTS.

By John Birmingham, Esq.

The accompanying sketches represent a remarkable group of spots that lately appeared on the sun, and formed one of a line of groups that crossed the disc at about 10′ from the southern limb.

Fig. 1 shows the group as I first saw it, in nearly the middle of the line, at 4 o'clock on June 25. The principal spot struck me at once by its display of a light-sinus of extraordinary brilliancy, together with what I might term a *nucleus in nucleo*—a small space of intense blackness within the ordinary nucleus. This is seen in the figure close to the right edge of the sinus.

The group was not observed on the 26th, but fig. 2 shows it as it appeared on the 27th, when several changes had evidently taken place. The light-sinus had disappeared, but three or four small bright spots were seen just within the edge of the nucleus towards its western end; and the nucleus itself had notably increased in size—partly, as it seemed, by the junction and extension of a number of small detached spots that tailed out from its eastern end on the 25th. The penumbra had enlarged proportionably, and a number of smaller spots, which formed a subdivision of the group to the east, had apparently moved slightly northward, with various changes among themselves. I may here state that the direction of the spots in the sketches, from below upwards, is nearly E. and W., and, as I drew them as they were seen with a sun-prism, the north is to the right. I may add that the first three figures were drawn partly by estimation, and the last three altogether by measurement. The small black *nucleus in* *nucleo* was not noticed on the 27th, neither was it apparent on the 28th; owing, probably, to the very bad definition on those days, as it was well seen afterwards.

On the 28th (see fig. 3) the large nucleus seemed to have cast off again one of the additions that it showed the day before, while some detached pieces appeared to have joined the penumbra. The small spots exhibited several changes, and a continued tendency to move towards the north.

Fig. 4 represents the group at 4h. on the 29th, when, in the great nucleus, the intensely black spot was again visible, with a light-sinus running up by its border as on the 25th; but the light-sinus was now of very inferior brilliancy. The small spots were, with one or two exceptions, much diminished in size and number, and seemed still to show the movement northwards, with also a westerly inclination. The measurements on this day were:—

Length of great nucleus	0′ 29″·5
Greatest breadth of ditto	0′ 11″·3
Length of penumbra	1′ 6″·2
Breadth of do. *a*——*b*	0′ 48″·0
Do. of do. *c*——*d*	0′ 40″·0

Allowing 450 miles as the value of 1″ on the surface of the sun at this date, without taking projection into account, the measurements would give the nucleus a length of 13,275 miles, and the penumbra 29,790.

On the 29th, at 22h., the group had assumed the appearance shown in fig. 5. The interior black space was still visible in the nucleus. The subdivision of small spots, in diminished numbers, seemed now advancing to the west, and formed a line nearly perpendicular to the length of the large spot. The measurements were:—

Length of great nucleus	0′ 31″·39
Extreme breadth at western end of do.	0′ 13″·97
Length of penumbra	1′ 23″·71
Breadth of do. *a*——*b*	0′ 43″·60
Do. of do. *c*——*d*	0′ 24″·40

The day following I had no observation, but on July 2, at 0h. 52m., the large spot, now nearly at the limb, appeared as in fig. 6. Its diminished breadth might, perhaps, not have been altogether due to perspective, and the nucleus showed marked symptoms of breaking up. The measurements were:—

Total length of line of detached nuclei	0′ 26″ ·0
Do. of upper larger nucleus by itself	0′ 13″ ·0
Breadth of do.	0′ 2″ ·6
Length of penumbra	1′ 10″·63
Breadth of do.	0′ 7″·84

The smaller spots were not distinguished.

I am not aware of any previous notice of the intensely black space within the nucleus, and it would be convenient if, in describing the spot, I could use the three terms—"nucleus," "umbra," and "penumbra." The apparent proper motion of the small spots might be caused by the disappearance of some or all of them, and the formation of others in adjacent positions. The larger ones, seen in figs. 4 and 5, preserved their relative positions with respect to the principal spot. During the time of my observations there was another line of fine spots on the northern zone.

JOHN BIRMINGHAM.

Millbrook, Tuam: July 16, 1869.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

ZETA CANCRI.

Sir,—You did me the favour of inserting a letter in the *Astronomical Register* of last June, in which I related some observations I had made of the close pair in ζ Cancri on the 7th of May previous; and also gave an estimate of the distance between them at that time, from the appearance they presented, with different apertures applied to my 18-inch reflector.

I stated that with 8 inches the star was *single*, very nearly round, barely elongated; with 12, 14, and 16 inches, notched more and more deeply, and with 18 inches the discs were just separated. The atmosphere was so still that the stars appeared perfectly motionless. On the following evening at the same hour, I repeated the observations with the same result, except that, the air being not quite so good, the discs hung in contact even with 18 inches. These observations were made in broad daylight, a few minutes after sunset, when star discs are free from irradiation, and appear smaller and clearer than can be the case in a dark sky. The power in all cases was 510. I have observed the pair many times this spring, and the first view showed me how much the distance was altered. They have been widening considerably, and the angle is changing fast. It is now a comparatively easy object. With 18 inches the discs are nearly as wide apart as the diameter of the smaller star. They are clearly divided with 12 inches, just in contact with 10, and widely elongated and deeply notched with 8 inches.

I have been told that a good 8-in. reflector will divide them now; but having on the 1st of this month, just before sunset, seen this object as clearly defined and motionless as if engraved upon paper, and finding the discs a little squeezed together with 8 inches, I am led to doubt the correctness of my information.

The readers of the *Astronomical Register* are aware that the accuracy of my observations last spring has been called in question by Mr. Buffham, who states that he divided the close pair quite easily in March 1868 with 9-in. of aperture and power 350, and judged the distance to be more than 0″·56. And again, in December 1868, he says he saw the stars divided with "a clear blank space between round discs, with power 320; the distance must be therefore 0″·6 ±."

These statements are so totally at variance with my observations of this object, made with great deliberation under unusually favourable circumstances, that I cannot attempt to reconcile them.

With every disposition to acknowledge an error on my part, if I have really made one, I cannot help saying that there are certain facts (independent of the notes I made at the time) vividly impressed upon my memory, which, to my mind, put such a supposition out of the question, viz. my having seen the star *single* in May 1868 slightly bulged at the side, with 8 inches; whereas now the two stars are distinctly visible with that aperture. And again, with 12 inches the two stars were much squeezed together, merely notched, in May 1868, whereas now they are well separated: there being no motion whatever of the star images to disturb the judgment on either occasion.

Without a micrometer it seems absurd to give an extract of position but, having let the star run along the wire in the eye-piece, and made a diagram (which, on repeated comparison with the stars themselves, seemed quite satisfactory to the eye), I find the position of A B to be between 190° and 195°; showing a retrograde motion of more than 50° since Mr. Dawes' last measure in 1865.

I hope some one better provided than myself has measured the positions in 1868 and 1869, as this is a part of the orbit of which we have no record whatever.

I am, Sir, yours faithfully,
HENRY COOPER KEY.

Stretton Rectory, Hereford:
May 7, 1869.

THE MOON'S ROTATION.

Sir,—You ask if some of your correspondents cannot settle the matter of the moon's rotation. The few remarks that may fall from my pen will, I am persuaded, go a very little way in bringing about so desirable an end. For myself, I am perfectly satisfied of its rotation or turning round on its axis, whichever your correspondents like to call it, otherwise day and night, morning and evening, could not occur on its surface as they do now; its solar day would be lengthened to 365 days or thereabout. Ferguson, in his Astronomy, section 262, says, "That the moon turns round her axis in the time that she goes round her orbit, is quite demonstrable; for a spectator at rest, without the periphery of the moon's orbit, would see all her sides turned regularly towards him in that time. She turns round her axis from any star to the same star again in 27 days 8 hours; from the sun to the sun again in 29½ days: the former is the length of her sidereal day, and the latter the length of her solar day. A body moving round the sun would have a solar day in every revolution, without turning on its axis, the same as if it had kept all the while at rest, and the sun moved round it; but without turning round its axis it could never have one sidereal day, because it would always keep the same side towards any given star."

In Mr. Perigal's experiment of the compasses, one thing appears to have been overlooked—viz., that *both* legs rotate or turn round in exactly the same time, which is very different from the earth and moon, for while the moon makes one revolution or turn round the earth as regards the stars, the earth makes 27⅓ turns round its axis; if the sun be regarded as the body of reference, the earth turns on its axis 29½ times. The following sentence may embody the whole matter: "The moon, as seen from the earth, *appears* not to rotate on its axis."

I am, Sir, your obedient servant,
Walthamstow: April 3, 1869. W. R. BIRT.

THEORY OF COMETS.

Sir,—Let me ask the favour of replying to Mr. Dawson's criticism on my "Theory of Comets;" and if you will permit me to address him in the second person instead of addressing him through you in the third, I may be able to convey my meaning with greater ease.

Mr. Dawson—Dear Sir,—To say that I feel grateful to you for the attention paid by you to my views on comets, expresses the truth but faintly; you have got many of my ideas, and I am glad to see you receive some of them; had my papers been accompanied with diagrams, I do not doubt but you would have got the ideas I wished to convey in every case; and then I feel sure you would have received my theory as a whole.

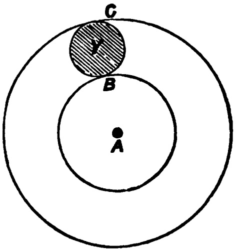
Permit me to reply to what I regard as your most important objections first. You say on page 47: "With respect to the tail over-reaching the head, and passing on in opposition to the sun, it is simply impossible; all bodies, *or parts of bodies*, must . . . lag behind those nearer to the sun."

This contains the essence of an objection which, if true, must prove fatal to a great part of my theory; but if I can clearly show, so that it will admit of no mistake, that there are exceptions to this rule, and that comets really form one of the exceptions, your weighty objection will be removed.

And in order to do this, you will pardon me when I ask you to follow me whilst we examine the simple and known laws by which bodies moving around a centre of attraction must necessarily be governed. It is for lack of seeing clearly all the results flowing from the operation of laws, themselves long known, that we have till this late hour missed the key which solves the unfinished problems of the solar system. We are not descending below our position when we stop to examine the most elementary laws which govern moving bodies.

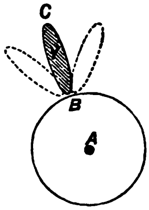
We will examine first separate bodies moving round a centre; 2nd, different parts of the same body moving around a centre, one body elongated; or 3rd, two bodies united by a connecting medium moving around a centre. First then, that separate bodies moving around a centre of attraction, such as the sun is, will move at different rates, the one nearest the centre moving faster than the more distant one—is a fact clearly proved by Kepler's laws. This must be so, from the fact that attraction increases as the square of the distance diminishes, and as the inner body is attracted by the centre more strongly than the outer one; if the inner one did not move faster than the outer one does, so as to have a greater centrifugal force than the more distant one, it would infallibly fall into the body attracting it at its centre of motion. On this point, then, you see we agree.

But, in relation to parts of the same body, the case is widely different, as the following fig. clearly shows. Let A be a centre of attraction and motion, around which the body Y revolves. The inner part of Y must pass around A in the orbit or circle B (which we may suppose at any distance from A, say 3 units), while the outer part will move around it in the circle C, at a distance of 9 units. Now, the circumference of the circle B is about 18 units, and that of C 54 units. It is certain, then, that the outer part of Y must move faster than its inner part (notwithstanding the fact that it is farthest from the centre A), for it passes over its circle or 360° in the same time that the inner part passes over the 360° of its smaller circle. Thus, if the inner part passes over 9 miles per second of time, the outer part must pass over 27 miles per second. The statement, then, that "parts of bodies must move slower the more distant they are from the centre, or sun," you see, is not correct.



The true rule is this: *The more distant the part of a body is from the sun, or centre, the* MORE *rapidly it must move.* Perhaps this may be the best place to refer to the known forces, *momentum* and *centrifugal force*; for we must fully understand the work accomplished by those forces before we can apply the laws of force to the case of comets. The body Y moving around A at the supposed rate of 27 miles per second, would, in consequence of the inertia of matter, require a certain force to stop it; and if it moved at a greater rate, it would require a still greater force to accomplish the same result. *The faster a mass moves, the greater is its momentum.* This is well known; let us not forget it during our investigations.

Again, a body moving around a centre will have a tendency to fly from that centre, and this tendency will become greater if the rapidity of the motion be increased: we call this centrifugal force. Let us watch it closely, for it will unfold wonders, not only in relation to comets, but to other bodies of the solar system. Let us refer to our diagram and apply this law; in fig. 1, Y moves around A, but the outer part of the mass moves faster than the inner part, and its centrifugal force will be greater at C than at B, but the attraction of A is greater at B than at C, and the result must be that the outer part, whose centrifugal force is greatest, will have a tendency to fly off from the inner part; and if the mass be composed of yielding matter, it will in reality do so, and the body, instead of continuing globular, will be *elongated* more or less according to the rapidity with which it moves. Try to get the import of the law of centrifugal force, and you will see this must be so; and, further, that this process must continue as long as motion continues; and thus, after being acted on for a certain time, it will assume a long elliptical, instead of its original globular form, and I need not say now that the longer it becomes the faster will be the motion of the outer part. Let us follow the course of such a body around its centre of motion.

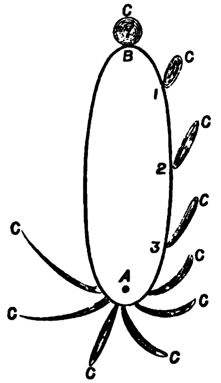


When the mass has attained the figure of a long eclipse as in Fig. 2, it is evident that so long as cohesion holds the mass together, B and C must complete their revolution in the same time; but as C is much further from it than B is, its tendency will be to go much slower, which it would do, but for its connection with B. In consequence of this tendency to fall behind, and being composed of yielding matter, C will be found a little behind a line drawn through A and B, but its rate of motion will be very rapid compared with that of B.

Hoping that the foregoing is fully understood, we will advance one step further.

Suppose we could by some means retard the motion of the inner part of Y (put on a brake at B, as we apply a brake to the wheel of a car when we wish to reduce its speed), what now will be the result? B will be retarded, perhaps all but stopped, whilst C, not being thus acted on, will pursue its course at its former rate; hence it must now pass over a greater arc of its circle than B does in the same time, and will not only come up to the line joining A and B, but will actually move in advance, and draw B after itself.

You will naturally ask, how is B retarded? where and how is the brake applied? we trace the inner part of the body through the whole of its course, and in the whole circle we can find no retarding power; *nothing to apply the brake.* Let us not give up in despair; we recollect the heavenly bodies *do not move in circles*; and comets especially move in those sections of the cone which are the most removed from the circle—in some cases hyperboles perhaps, paraboles, or long ellipses. Let us examine the motion of the body Y whilst passing over either of these curves, and mark the result. We will select the ellipse. Suppose the mass Y to start from B moved by the attraction of the centre A: it must move onward to 1, 2, 3 on the orbit, getting nearer to the centre of attraction every moment, and, as a consequence, moving with increasing speed, the outer portion moving over a larger orbit, and faster than the inner one, until the inner part arrives on the lines of the apsides of the ellipse, at which point it will be very near the centre of attraction: here it ceases to approach that centre, and, at that very moment, *the brake is applied.* The attraction which, till now, drew it towards the centre, still acts with equal force; but it is now to retard Y's motion, and, but for Y's momentum, it would be stopped altogether.



But this retarding force is not acting on the end of the mass C; for it has not yet reached the line of apsides of the ellipse which forms its orbit: its motion must be still increasing, and when it reaches the point where the retarding force is applied, C is at such a distance from A that A's attraction, which diminishes as the square of the distance increases, acts with a small force on C, when compared with its attraction on B; so that momentum will carry C around, and instead of moving slower than B at this point, it will move more rapidly, and still keep the part B turned toward the centre.

On this point I shall cease writing. I hope you see my meaning throughout; if so, let me ask you to take up my theory of comets, and read it again. You will find no difficulty in applying the laws we have been examining to the case of comets; and I feel sure you will adopt my views.

And you will permit me to state that every month brings me confirmation of my theory. When I first thought and wrote in this manner, no man on earth, so far as I know, ever suspected that our November shower of meteors was caused by a ring which had been formed by the dispersion of a comet. Now Adams, Lynn, Proctor, and I suppose all others, receive it as an established fact. And I see in the *Student* for February, that Proctor has either adopted my views on the Zodiacal light, or else he has arrived at the same conclusion from a different process of reasoning; and in that case, I regard it as strong proof of the correctness of my theory. In fact, astronomers are here and there uniting together two links in the chain, whilst my theory follows causes and effects, from the first link to the last. I shall wait with patience; it will yet be received by all.

In a future letter I will answer the remainder of your objections; but if you fully grasp the theory, I hope you will have done so for yourself before that time arrives.

I have sent a third letter on "Comets' Nuclei" to the *Register*, and hope it will remove some of the objections in regard to their physical constitution.

As soon as the *Register* can afford me space, I shall offer its readers a lunar theory, which I regard as equally important with that of comets; and in Mr. Dawson I feel sure I shall have one attentive reader.

I am, most sincerely yours,
A. ELVINS.

P.S.—I have no idea that all comets are gaseous only: some may have solid nuclei, others not. My theory meets either case equally well; and if we suppose the comet's head to be represented by B in our figure, and the outermost portions of the tail by C, we shall see that the tail is quite as obedient to the laws of gravity as the head. A. E.

ON THE CONSTRUCTION OF OBSERVATORIES.

Sir,—I think I can afford your correspondent "P." some little information respecting flat-roofed observatories, I having myself just erected such an one, of which I send you a sketch, at right angles to the meridian.

It is in the form of a parallelogram, 21 feet long from E. to W., and 13 feet from N. to S. internally.

Two strong joists *a a*, parallel to the meridian, and having a clear space of 12 feet between them, rest on the N. and S. walls, and the space between each joist and the adjoining wall is permanently roofed in with inch board, covered with felt. On top of these joists, and on top of the inch sheeting, two wooden rails, 28 feet long and 3½ × 3 inch, are bolted down. These project some 13 feet beyond the N. wall of the observatory, where the projecting ends are supported on a suitable wooden framing.

On the upper side of the rails a light cast-iron channel, in 3-feet length, is screwed: the section of this is concave, being half-an-inch deep and 2 inches wide; in this channel the wheels supporting the roof run backward and forward from N. to S.

The movable portion of the roof is 14 feet long from N. to S., by 12–6 from E. to W. It is composed of boards 12–9 long × 7 inches wide, and ¾ thick.

A number of these are nailed together by means of ledges running N. and S.; the two outer ledges are strong, being 3 × 2½ inches, and their upper sides are bevelled to a certain angle.

These outer ledges are drawn together 2½ inches by three hoop-iron ties, which converts the flat surface into an arch of 9 inches rise.

The angle to which the upper surface of the rail is bevelled is such that the lower surface is now horizontal.

In each of the outer rails are three mortise soles, in which cast-iron wheels 3½ inches diameter revolve on steel pins, driven right through the wood. The wheels project half-an-inch beneath the lower surface of the rails. The roof is covered with tarred felt, and is strong enough to bear the weight of two men. It moves so freely that, by means of a single cord and pulley, you can easily move it backwards and forwards, even when there is a man standing on it. It is perfectly waterproof, and in every way satisfactory. The cost of the entire roof, wheels, and railway, put together by a country carpenter under my own superintendence, was less than 5*l*.

To admit of the roof being closed, the telescope must be placed horizontally in the meridian, in which position the tie rods of the roof just clear it. In the S. wall there is a shutter, equal in length to the breadth of the roof, and 18 feet deep, hinged along its lower edge; this shutter, opening outward, permits the telescope to command the horizon.

Also, when looking E. or W., the telescope commands the horizon, for the mounting being somewhat on the plan of German equatorials, and the distance between the axis of the telescope and the Polar axis being 21 inches, the elevation due to 90° motion in the plane of the equator suffices to lift the telescope, when pointing E. or W., completely above the roof. Not that there is the least advantage in looking at an object, within 10° or 15° of the horizon, with large telescopes.

The E. and W. ends of the observatory, so far as they are covered in with the permanent roofing, are separated by partitions and curtains from the central open part.

The telescope mounted in this observatory is the 7½-inch one, first sent by Alvan Clarke to Mr. Dawes, and which, I have been given to understand, he considered more perfect than any of its successors.

If I were constructing another observatory, it should be on the same plan as the present, with the following alterations, viz. I would have it altogether of wood, covered with felt, and instead of having two closets, E. and W. of the telescope, I would have but one, and that N. of it.

Hoping that these particulars may be useful to Mr. P.,

I remain, faithfully yours,
WENTWORTH ERCK.

Sherrington, Bray, C. Wicklow:
May 25, 1869.

ROTATION.

Sir,—The peculiar views which certain persons hold upon the subject of rotation have been maintained with a persistence and energy which seem to arise from a conviction that there is involved in the question an important fundamental principle, upon which the whole mathematical world are in error.

It has been pointed out more than once that, in truth, the dispute is at best but a mere question of definitions, and that when once the meaning of the word "rotation" is fixed, there can be no difficulty in determining whether in any particular instance rotation does or does not exist. Of course, every one is at liberty to define for himself the meaning which he chooses to attach to the word, although a multiplicity of definitions is obviously inconvenient, and necessarily tends to confusion.

There is, however, this inherent weakness peculiar to the case of the non-rotationists, which shows clearly how unphilosophical and inconvenient is their conception of rotation, viz. that it is impossible to frame any definition, consistent with their views, which does not lead to absurdity and self-contradiction; and accordingly, numerous and ingenious as are the examples by which they endeavour to illustrate their meaning, I do not recollect that any one of them has ever ventured to bring his notions to the test of an accurate and rigid definition. It strikes me forcibly that if, instead of multiplying illustrations which prove nothing, they would apply themselves to the task of defining strictly what they mean by "rotation," the hopelessness of the attempt would convince them that their position is untenable.

To show this briefly: the definition must be such as to exclude the case of a body moving, like the moon, around an axis external to itself. Now suppose we define rotation by saying that "a body rotates when and only when it moves round an axis *within* itself." (For simplicity I will confine myself to motion in one plane.) Now, agreeably to this definition, a wheel turning round a point just within its circumference rotates, but if the small portion including the centre of motion be cut off, the wheel no longer rotates, although the motion is unchanged; hence the same motion is described one moment as rotation, the next as non-rotation, which is clearly absurd. This definition will therefore probably be rejected at once. But now try another: "A body rotates when it moves round an axis passing through its centre of gravity." Of course, according to this, a wheel turning round its axle rotates, but attach the smallest particle to any part of the circumference and it ceases to rotate, although the motion is precisely the same, because the centre is no longer the centre of gravity. Such a result I should think too ridiculous even for the non-rotationists. But suppose, to avoid this absurdity, we say that "a body rotates when it turns round an axis passing through its centre of figure," once more recurring to the wheel turning round its axle;—if there is the smallest projection or depression on any part of the circumference, the wheel is not rotating, for the centre is not accurately the centre of figure. These illustrations may suffice. Whatever way the definition is framed, the same difficulty inevitably crops up, and I defy the non-rotationists to produce a definition that will not result in contradiction and absurdity.

By way of contrast, I commend to their attention a definition in accordance with the usually received meaning of the word "rotation," viz. "that a body rotates when it moves in such a way that any line drawn within the body does not remain parallel to its original position."

G. P. B.

SPOTS ON THE FLOOR OF PLATO.

Sir,—May I solicit the attention of lunar observers, through the medium of your columns, to the floor of Plato? Webb, in his second edition of "Celestial Objects," mentions the light and dark streaks; also several little craters, more particularly a central one, and "two quite close, like a double star (Dawes)." According to records and drawings which I have collected during the last ten years, I find that as many as twenty-two have been observed. Eleven have been seen at the same time, by Mr. Pratt, on February 23, 1869—a solitary instance as regards the number seen. Seven have been seen together on three occasions by Gruithuisen and Gledhill, but it is remarkable that the *same* spots have not been seen on each occasion. Three of those seen by Gruithuisen have been seen by Pratt, Gledhill, and other observers; the remaining four seen by Gruithuisen have not been detected since his time, except one, which was suspected by Mädler. With the exception of Gruithuisen's three, which appear to be the most persistent, the seven seen by Gledhill on two occasions are not identical. The order of discovery of twenty-one is as under:—

Gruithuisen	discovered	8	3 only have been satisfactorily observed by succeeding observers.
Mädler	„	1	which has been re-observed.
Challis	„	1	which has been re-observed.
Dobie	„	1	which was re-observed by Dawes in the same year, but not since.
Knott	„	2	neither of which have been re-observed.
Pratt	„	7	4 re-observed by Gledhill.
Gledhill	„	1	observed by him twice, but by no other observer.

Of the above, ten may be considered as visible, under favourable circumstances, at the present time; but the question arises as to the visibility of the remaining eleven. If the floor of Plato exists in the state which the surface of the moon attained myriads of ages ago, it is difficult to perceive the reason why some of these spots should be visible under suitable atmospheric circumstances and others not. The inferiority of the instruments formerly used may account for the recent discovery of Pratt's and Gledhill's with apertures of 8 and 9 inches, but leaves entirely unexplained the non-visibility of Gruithuisen's, Dobie's, and Knott's. The desideratum necessary for elucidating the question is the determination by alignment of the positions of those recently observed; they should be referred to objects on or near the border of Plato.

I am, Sir, your obedient servant,

W. R. BIRT.

Cynthia Villa, Walthamstow:
July 2, 1869.

LARGE OBJECT-GLASSES.

Sir,—Will some of the readers of the *Register* who have studied optics give me their opinion in reference to the construction of a large object-glass, 18 inches clear aperture, and 18 feet 3 inches in focal length? Is there a possibility of producing good definition with so large a glass, so short in focal length? Supposing the focal length of the crown lens to be 6 feet 10 inches, and the combined length 18 feet 3 inches, what would be the best curves for the crown and what the best curve for the flint lens on the side next to the crown lens? Is there any reason why the two surfaces of the crown and flint lenses in contact should not be of the same curvature, so as exactly to fit into each other?

The 12½-inch object-glass which I constructed and have had in use for some time has afforded me many hours' pleasure, both by night and by day. Observations on the sun this spring continue to be very interesting, the spots being so large and numerous; I have counted more than a hundred, large and small, on the sun's disc at one time. Yesterday, May 13th, there were four groups of spots to be seen. From the side of the penumbra of one of the spots there was the resemblance of three fingers extended and thrust partially across the dark spot.

On the evening of February 18th I observed the moon and saw Linné in both its features, as a bright hill and as the dark crater. The bright hill was seen at 7 P.M., the dark crater at 7·30 P.M.; the mistiness so generally seen hanging over it had nearly all disappeared at the time.

T. WHITEHOUSE.

Seager Street, West Bromwich:
May 14, 1869.

PEAR-SHAPED ELONGATION.

Sir,—In continuation of my letter which you have been so good as to print in the *Astronomical Register* of this month, permit me to add, that when the hand is removed to the proper distance from the eyes, for distinct vision—9 or 10 inches—the illusory anticipation of contact between two approaching fingers will not occur. This corollary to the experiment may possibly suggest the cause of the pear-shaped protuberance itself:—viz. that, as either sun or planet *must* be out of focus when in the same field of view of a telescope, the edges of *both* cannot be seen distinctly, and the result is the phenomenon in question.

It is further possible that the limb of the planet may become elongated towards the sun, or that of the sun towards the planet, according as one or the other happens to have been accurately focussed.

If so, two neighbouring telescopes, one adjusted on the planet, the other on the sun (if that were practicable), *might* give different times of contact, and their mean be taken for the true moment. But all this is wild conjecture. In November 1861 I observed the transit of Mercury with a large refractor, and perceived no sensible elongation: others saw it decidedly.

I am, Sir, yours faithfully,
London: May 6, 1869. ARCITINENS.

Dr. Tyndall's Theory of Comets.—The *Philosophical Magazine* for April contains the following speculation regarding the origin and deportment of visible cometary matter enunciated before the Cambridge Philosophical Society by Dr. Tyndall on the 8th of March 1869. We give the conclusions only, referring to Professor Tyndall's letter in the *Philosophical Magazine*:—

"1. The theory is, that a comet is composed of vapour decomposed by the solar light, the visible head and tail being an actinic cloud resulting from such decomposition; the texture of actinic clouds is demonstrably that of a comet.

"2. The tail, according to this theory, is not projected matter, but matter precipitated on the solar beams traversing the cometary atmosphere. It can be proved by experiments that this precipitation may occur either with comparative slowness along the beam, or that it may be practically momentary throughout the entire length of the beam. The amazing rapidity of the developments of the tail would thus be accounted for without invoking the incredible motion of translation hitherto assumed.

"3. As the comet wheels round its perihelion, the tail is not composed throughout of the same matter, but of new matter precipitated on the solar beams, which cross the cometary atmosphere in new directions. The enormous whirling of the tail is thus accounted for without invoking a motion of translation.

"4. The tail is always turned from the sun for this reason. Two antagonistic powers are brought to bear upon the cometary vapour—the one an actinic power tending to produce precipitation; the other a calorific power, tending to effect vaporisation. Where the former prevails, we have the cometary clouds; where the latter prevails, we have the transparent cometary vapour. As a matter of fact, the sun emits the two agents here invoked. There is nothing whatever hypothetical in the assumption of their existence. That precipitation should occur behind the head of the comet, or in the space occupied by the head's shadow, it is only necessary to assume that the sun's calorific rays are absorbed more copiously by the head and nucleus than the actinic rays. This augments the relative superiority of the actinic rays behind the head and nucleus, and enables them to bring down the cloud which constitutes the comet's tail.

"5. The old tail, as it ceases to be screened by the nucleus, is dissipated by the solar heat; but its dissipation is not instantaneous. The tail leans towards that portion of space last quitted by the comet, a general fact of observation being thus accounted for.

"6. In the struggle for mastery of the two classes of rays a temporary advantage, owing to variations of density or some other cause, may be gained by the actinic rays, even in parts of the cometary atmosphere unscreened by the nucleus. Occasional lateral streamers, and the apparent emission of feeble tails towards the sun, would thus be accounted for.

"7. The shrinking of the head in the vicinity of the sun is caused by the beating against it of the calorific waves, which dissipate its attenuated fringe and cause its apparent contraction.

"Throughout this theory I have dealt exclusively with true causes, and no agency has been invoked which does not rest on the sure basis either of observation or experiment. It remains with you to say whether, in venturing to enunciate it, I have transgressed the limits of rational speculation."

MR. PENROSE ON PREDICTIONS OF OCCULTATIONS.—We have just received Mr. Francis Cranmer Penrose's new book, entitled *A Method of Predicting, by Graphical Construction, Occultations of Stars by the Moon &c.* In the absence of a transit or altazimuth instrument, there is, says Mr. Penrose, no mode of determining the longitude so precise as the observation of the occultations of stars by the moon. The chief objection that sailors and others may have had to this mode of finding the longitude has been the obstacle presented by the preliminary calculations, quite as much as by any difficulty in making the observation itself. Glasses used by sailors and others are now so much better than they used to be, that anyone can observe the occultations of stars of the 3rd or even 4th magnitude, against the dark limb of the moon; even a good opera-glass will enable an observer to do this. He thinks, therefore, that if the prediction of occultations can be made more inviting and expeditious, as by a graphic method, than by the usual mode of calculation, it will be a boon to the sailor and scientific traveller. This want the book before us supplies; and in addition to this, those who prefer the use of calculation to graphical construction, and who would naturally resort to the well-known treatise of Rear-Admiral Shadwell, are referred to the tables and rules for reduction of observed occultations and eclipses which this essay affords, as a useful supplement to that work. The graphic process may be expected, with ordinary care, to bring out a prediction for any given latitude or longitude, not differing more than three minutes from the truth, with the expenditure of ten minutes or a quarter of an hour. In respect of reduction of observed occultations, by help of Chart II., a result as close as half a minute may be expected. The great aim of the writer has been to make the process as intelligible as possible, each step being explained clearly. Without professing novelty of principle for his graphical mode, Mr. Penrose claims for his book difference in detail from any similar works, from none of which he has copied. The book is evidently one upon which great pains have been bestowed, and we believe it will lead to useful results.

THE PLANETS FOR AUGUST.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	8 42 9	+19 46½	5″·2	23 42·0
	20th	10 32 9	10 50½	5″·0	0 36·6
Venus	5th	10 36 38	+10 20	10″·8	1 40·1
	20th	11 43 56	2 55½	11″·6	1 48·2
Jupiter	5th	3 7 57	+16 24	37″·4	18 8·7
	20th	3 13 5	16 42	39″·2	17 14·8
Saturn	5th	16 36 55	−20 29½	15″·8	7 39·4
	20th	16 36 44	20 32½	15″·4	6 40·2

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To September 1869.

Jackson, Mrs. H.
Jenkinson, Rev. J.
Wright, W. H.

To October 1869.

Burlingham, R.
Lewis, H. K.

To December 1869.

Briggs, Miss.
Dawson, A.
Freeman, D.
Guyon, G.
Holden, W.
Hubbersty, Rev. C.
Kershaw, A.
Prince, C. L.

To December 1870.

Compton, A. J. S.

July 16, 1869. Subscriptions received after this date in our next.

NOTICES TO CORRESPONDENTS.

Received Illustration of Total Eclipse of Sun as seen in the Wabash Valley, near Vincennes, 5.10 P.M. local time, August 7, 1869, from Mr. N. S. Gilman, Fern Lodge, Rocklands, New York.

To SUBSCRIBERS.—We beg to remind some of our friends that they have failed to remit their Subscriptions. In a short time, we purpose sending them a Memorandum of their Arrears, and we hope that they will kindly at once forward the amounts due. At the same time, we thank those of our kind supporters who have so continually helped us by promptly and generously remitting their payments in advance.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

BRIGHT BODIES ON THE SUN.

Sir,—On the 6th instant, at about 3h 20m G.M.T., I turned my refractor from the Sun, which I had been observing for half-an-hour, to the planet Venus. I focussed the planet with card, and of course saw nothing remarkable or different from its usual appearance so near conjunction. I had not looked through the glass above three minutes, before a large meteor left the neighbourhood of the planet, and descended slowly across the field of the telescope—I should say occupying from two to three seconds in crossing half the field of about 70'. As the telescope was clamped in declination, and I could not reach the handle without losing sight of the object, I was unable to follow its course. Judging from the apparent diameters of the planet and the meteor, the disc of the latter would be about 3", taking the planet as 9" to 10". My telescope is an equatorial of 6 in. clear aperture, and is a very fair instrument. As the appearance was to me remarkable, I have taken the liberty of mentioning it to you, as I am certain it was no delusion, and I never saw a meteor in full sunshine before.

Yours truly,

Sleaford: June 10, 1869. R. W. PAYNE.

THE THIRD SATELLITE OF JUPITER.

Sir,—Probably the question of the visibility of the third satellite of Jupiter at its greatest elongation without a telescope would never be settled by discussion, and I will therefore only intrude further on your space to say to your correspondent "C" (May, p. 112,) that I am unable to understand that a certain example of *defining* power on mere angular subtension is the guage with which to judge *another* optical power usually held to be quite distinct from the former, and sometimes designated "*light-grasp.*" I have previously given my reasons for charging only the latter with the task of exhibiting the light of this small point, and have therefore still no reason to alter my belief that with a simple method of getting rid of some of the irradiation of the planet, (which has also the advantage of dilating the pupil of the eye,) enough has been caught to indicate its position, especially as this has been tested by immediate reference to an instrument.

I am, Sir, yours truly,

Earith, Hunts: June 11, 1869. T. H. BUFFHAM.

SPECTRUM OF AURORA.

Sir,—Though I do not know that auroras have any connection with astronomy, yet as they are mentioned in your periodical I venture to describe the spectrum of the brilliant one on the 13th ult., as seen with a common prism. I saw five bright lines, naming them α, β, γ, δ, and ϵ, beginning at the red end; β is the one described on your p. 98, α was red, and was the only one I could see decidedly coloured, though it and γ were the faintest. β is visible in all auroras I have examined, unless they are very faint; and in all it has been by far the brightest part of the spectrum, except in the upper part of the aurora of April 16. δ was the next brightest line. There was faint light between the lines from β to ϵ, and this line was sometimes brightish from β to δ. There was scarcely any perceptible difference between the spectrum of the greenish and of the deep crimson part of the aurora; the difference seemed only to be in the relative brightness of the lines. On April 16, though neither α nor γ was visible, there was a line between β and γ. ε is, I believe, between the solar lines F and G, nearest G; but I should like to know what kind of spectroscope would be most suitable for observing auroras, and for ascertaining the positions of the lines; and where such a one could be obtained.

Yours truly,

Sunderland: 10, 6, 69. T. W. BACKHOUSE.

PLANETARY TRANSIT: AURORA.

Sir,—In recent numbers of the *Astronomical Register* various methods are proposed for illustrating the production of the black ligament seen during the transit of an inferior planet. These methods have one element in common, namely, one (at least) of the objects is out of focus. Possibly this may have something to do with the production of the appearance in question.

During the recent magnificent display of aurora, the following phenomenon was noticed and commented upon by myself and a friend who was with me: the stars in Cygnus, especially Albireo, seemed to have their brilliancy considerably increased whenever a wave of auroral light passed over them. This was early, (about 10 p.m.,) and before the grand display of colours; in the intervals they were scarcely visible, but with each wave they seemed to force themselves upon our notice.

I remain, Sir, faithfully yours,

176, Oxford Street, ARTHUR W. BLACKLOCK.
Manchester: June 5th, 1869.

THE TOTAL SOLAR ECLIPSE OF 1868.—On Thursday, May 13, 1869, at the Meeting of the North London Naturalists' Club, Mr. T. W. Burr, F.R.A.S., &c., delivered a lecture on "The Total Solar Eclipse of August 18, 1868, especially in reference to its Spectroscopic results," (being his third communication on Spectrum Analysis.) He commenced by some explanation of Eclipses in general, showing that those of the Sun are caused by the direct interposition of the Moon between the Earth and the Sun, and those of the Moon by that body plunging into the conical shadow thrown by the Earth. The reason why there is not an eclipse of the Sun at every new Moon, and and an eclipse of the Moon at every full Moon, was shewn to be that the orbits of the Earth and Moon are inclined to each other, and that eclipses can only happen when the Earth, Moon, and Sun are in the line of the Nodes; and as these intersecting points shift round in about 18¼ years, the eclipses are constantly varying during that period. The special phenomena of a total solar eclipse were then described; viz. Baily's beads, the corona, and red flames or protuberances, and also the general effects upon organic Nature. The remarkable circumstances attending the ancient eclipses of Thales, Agathocles, and Larissa were narrated, and the identification of the dates of these events by the researches of the Astronomer Royal and others detailed. The appearance sometimes seen, and known as Baily's beads, was referred to irradiation and other optical causes. The Corona was shown not to be an appendage of the Moon, but its real position and cause are not yet satisfactorily ascertained. A full account was given of the red prominences from the first observation in 1706 by Captain Stanyan, and 1733 by Vassenius, and their re-discovery by Mr. Baily, Mr. Airy, and the Continental astronomers in 1842, down to the present time. The eclipses of 1851 and 1860 were described in detail, and the photographs taken by Mr. De la Rue at Rivabellosa in Spain during the eclipse of 1860 exhibited, as also those taken near Valencia by Padre Secchi. From these it was clear that the bodies in question were in connection with the Sun, but their chemical and physical nature remained unknown. Attention was then directed to the favourable opportunity afforded by the recent eclipse for determining these points by means of the Spectroscope, an instrument which had been brought into use since 1860, and had revealed the cause of Fraunhofer's lines, and thereby the constitution of the Sun; and these discoveries had been carried on to the stars and nebulæ as detailed in Mr. Burr's previous lectures. The fundamental principles of spectrum analysis having been recapitulated, it was stated that two expeditions had been despatched from England to observe the eclipse of 1868, the one in charge of Major Tennant, the other under Lieutenant Herschel; while France had likewise sent two sets of observers to India, and the North German and Austrian Governments two parties to Aden. Enlarged copies of six photographs taken by Major Tennant were exhibited and described, and a diagram of their combined results shown. The spectroscope, by the accordant observations of Major Tennant, Lieutenant Herschel, M. Janssen, M. Rayet, and other observers, shewed conclusively that the red prominences gave a spectrum of bright lines, proving they were gaseous, and all agreed that the principal lines were those of incandescent hydrogen, although they differed as to the presence of sodium, magnesium, and some other elements. The subsequent remarkable double discovery by Mr. Lockyer and M. Janssen that the spectrum of the prominences could be seen without an eclipse, was narrated, as also Mr. Lockyer's later discovery that a continuous stratum of hydrogen existed round the photosphere, to which he gives the name of the *Chromosphere*, and the further fact ascertained by Mr. Huggins that by proper arrangements and precautions the actual shape of the prominences can be seen at any time: and some curious fluctuations in shape of the line F as seen by Mr. Lockyer having been noticed, the lecture concluded with the anticipation of still further discoveries respecting the nature and constitution of the Sun, which these recent successful researches rendered probable.

Numerous diagrams and pictures illustrating the speaker's remarks, including the causes and phenomena of eclipses, views in Spain, photographs of the red flames, the spectra seen in India, and other points of the subject, were shewn by means of the oxy-hydrogen lime light lantern, and spectra of some of the chemical elements exhibited by means of a table spectroscope.

THE PLANETS FOR SEPTEMBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension			Declination		Diameter	Meridian Passage	
		h	m	s	°	′		h	m
Mercury	5th	12	9	24	− 1	12½	5″·4	1	10·7
	20th	13	21	46	10	57	6″·2	1	23·9
Venus	5th	12	54	16	− 5	19½	12″·4	1	55·4
	20th	14	1	17	12	42	13″·2	2	3·3
Jupiter	5th	3	15	34	+ 16	49	41″·2	16	14·4
	20th	3	14	48	16	43½	43″·0	15	14·6
Saturn	5th	16	38	15	− 20	39	15″·0	5	38·8
	20th	16	41	10	20	47½	14″·6	4	42·7
Neptune	5th	1	13	0	+ 5	54½	—	14	8·2
	20th	1	11	42	5	46	—	13	11·9

ASTRONOMICAL OCCURRENCES FOR SEPTEMBER, 1869.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	1		Sidereal Time at Mean Noon 10 42 44·7	3rd Oc. D. „ Oc. R.	10 5 11 43	α Cygni. — 9 52·6
Thur	2	3 59 13 33 14 17	Conjunction of Moon and Uranus 1° 56′ N. Occultation, B.A.C. 2683 Reappearance of do. (6)	2nd Oc. D. „ Oc. R.	9 8 11 24	9 48·6
Frid	3		Meridian Passage of the Sun, 0m 51s before Mean Noon	1st Ec. D.	16 11 49	9 44·7
Sat.	4			1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	13 30 14 47 15 42 16 58	9 40·7
Sun	5	18 7	● New Moon	1st Ec. D. „ Oc. R.	10 40 20 14 6	9 36·8
Mon	6			1st Tr. I. „ Sh. E. „ Tr. E.	9 15 10 11 11 26	9 32·8
Tues	7	1 35 21 22	Conjunction of Moon and Mercury 5° 11′ S. Conjunction of Moon and Venus 4° 53′ S.	2nd Sh. I. „ Sh. E. „ Tr. I.	13 57 16 18 16 31	9 28·9
Wed	8	7 27 21 10	Occultation, disappearance of 80 Virginis (6) Conjunction of Moon and Mars 5° 48′ S.	3rd Ec. D. „ Ec. R. „ Oc. D. „ Oc. R.	8 41 11 10 32 28 13 51 15 26	9 25·0
Thur	9		Saturn's Ring: Major Axis = 37″·20 Minor Axis = 16″·61	2nd Ec. D. „ Ec. R. „ Oc. D. „ Oc. R.	9 6 53 11 22 12 11 36 13 51	9 21·1
Fri	10					Moon. — 3 54·8
Sat	11	16 42	Conjunction of Moon and Saturn 2° 53′ S.	1st Sh. I. „ Tr. I.	15 24 16 37	4 48·7
Sun	12	9 23	☽ Moon's First Quarter	1st Ec. D. „ Oc. R.	12 34 15 15 55	5 42·5
Mon	13	5 34 6 4 9 4	Occultation of μ^1 Sagittarii (4) Reappearance of ditto Conjunction, Venus and *h* Piscium (5m·0) W.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	9 53 11 4 12 5 13 5	6 36·0
Tues	14	6 27	Near approach of Moon to ϖ Sagittarii (3)	1st Oc. R. 2nd Sh. I.	10 22 16 32	7 28·5
Wed	15		Illuminated portion of disk of Venus = 0·819 of Mars = 0·943	3rd Ec. D. „ Ec. R. „ Oc. D.	12 42 12 14 32 57 17 32	8 19·4

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Thur	16		Sidereal Time at Mean Noon 11 41 53·0	2nd Ec. D. „ Ec. R. „ Oc. D. „ Oc. R.	11 42 54 13 58 11 14 1 16 16	Moon. — 9 8·3
Fri	17		Meridian Passage of the Sun, 5m 38s before Mean Noon			9 55·1
Sat	18			2nd Tr. I. „ Sh. E. „ Tr. E. 1st Sh. I.	8 8 8 11 10 23 17 18	10 40·0
Sun	19	5 7 5 53	Conjunction of Mercury and α Virginis (0m·2) E. Conjunction of Mercury and α Virginis 0° 1′ N.	3rd Tr. E. 1st Ec. D. „ Oc. R.	9 4 14 28 15 17 43	11 23·2
Mon	20	8 41	○ Full Moon	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	11 47 12 53 13 59 15 3	α Cygni. — 8 37·8
Tues	21			1st Ec. D. „ Oc. R.	8 56 44 12 10	8 33·9
Wed	22			1st Sh. E. „ Tr. E. 3rd Ec. D.	8 27 9 30 16 42 43	8 30·0
Thur	23	12 20 13 27	Occultation of ξ^2 Ceti (4) Reappearance of ditto	2nd Ec. D.	14 18 48	8 26·0
Fri	24	16 39	Conjunction of Moon and Jupiter 3° 47′ N.			8 22·1
Sat	25	4 52	Greatest Easterly Elongation of Mercury, 25° 55′	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	8 26 10 30 10 47 12 45	8 18·2
Sun	26			3rd Sh. E. „ Tr. I. „ Tr. E. 1st Ec. D.	8 53 11 5 12 36 16 22 21	8 14·2
Mon	27	16 4 17 24	Occultation of χ^2 Orionis Reappearance of do. (6)	2nd Oc. R. 1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	7 49 13 41 14 40 15 53 16 50	8 10·3
Tues	28	9 10	☾ Moon's Last Quarter	1st Ec. D. „ Oc. R.	10 50 52 13 57	8 6·4
Wed	29	14 28	Conjunction of Moon and Uranus 1° 41′ N.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	8 10 9 7 10 22 11 17	8 2·4
Thur	30		Saturn's Ring: Major Axis = 36″·06 Minor Axis = 16″·17	1st Oc. R. 2nd Ec. D.	8 24 16 54 36	7 58·5

THE ROYAL OBSERVATORY, GREENWICH.

◆

The following Extracts from the Report of the Astronomer Royal to the Board of visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory on the 5th of June, may be interesting to our readers.

ASTRONOMICAL INSTRUMENTS :—The *Transit-Circle* is in perfect order. I adverted in the last Report to small iron chips in the telescope-tube which gave us some trouble; at the first opportunity, these were extracted by the insertion of magnets, and we have had no further annoyance.—The screw-movements for focal adjustments, and the jointed sliding caps for the perforations in the central cube, have been found very convenient.—The *Reversed Telescopes*, for reciprocal observation through the perforated cube, and for carrying the wires which are observed as meridian-marks by the Transit-Circle, when proper care is taken for focal adjustment, give no trouble in the nature of systematic discordance, and are in all respects perfectly efficient.—The suspicion of telescope-flexure produced by the weight of the sun-shade, and not properly exhibited in the circle-readings, has led us to examine thoroughly the effects, not only of the weight of the sun-shade generally, but also of that weight under different applications of the clamps; and the result is, that there is no certain effect whatever.—The mean of our two series of determinations of graduation errors has been used, as was mentioned last year.—The conical milled head which I proposed for the telescope-micrometer was mounted last year.—The four supplementary microscopes have been removed. I shall speak hereafter of the results obtained by their use.—The proposed high class interior thermometer has been mounted in a position in which it may be expected to indicate fairly the temperature of the air near the object-glass. Several foreign astronomers have considered this important, as they think that the computation of atmospheric refraction is more consistently accurate if it is referred to the interior thermometer than if it is made to rely on the exterior thermometer.

The *Clocks* generally are in good order.—Two ounces of quicksilver were added to the bulb of the Transit-Clock-pendulum, and it does not appear to require more. Lime is used, as I mentioned in the last Report, to keep the air in the head of the clock dry; it is changed once each month.—The *East Dome Clock* (Earnshaw) has been cleaned, and an alteration has been made in its spring-suspension, to remedy a wobbling motion of the pendulum.—The *Ball Clock* (Graham 3) has been cleaned.—A new clock by Messrs. *Dent* is in progress. It is to be constructed with an escapement analogous to the chronometer-escapement, which produces maintaining power with a smaller amount of friction than any other. I have arranged a method of altering the rate without stopping or touching the pendulum, by a sliding weight upon the crutch-rod. I am endeavouring also to prepare a construction for altering the thermal compensation through a small extent, without touching the pendulum. I have not succeeded to my satisfaction in planning a barometrical compensation. I propose to place the clock in the Magnetic Basement, where the temperature is more uniform than in any other of our rooms, and to lead galvanic wires from it to the Transit-Clock and other clocks.—The *Motor Clock* (Shepherd's) for Mean Solar Time, by which time-signals are given and received, and sympathetic clocks are maintained in action, is in good order. The sympathetic clock used for chronometer-rating has been transferred to the new chronometer-room; and two new sympathetic dials have been mounted there, showing seconds only. A clock by *Dent*, used for chronometer-comparisons only when the galvanic process fails, has also been removed to the new chronometer-room.—The *Chronograph Barrel-Clock* and the *Chronograph* generally are in good order.

The *Reflex-Zenith-Tube* and the *Altazimuth* are in their usual efficient state, and require no special notice. They have received no alteration in the past year.—The *Shuckburgh Equatoreal* and the *Sheepshanks Equatoreal* are both in serviceable state. The latter has aperture approaching to 7 inches, and is furnished with clock-work, which, although not of a high order of excellence, is good enough to increase greatly the utility of the instrument.—The *South-East Equatoreal* is in excellent condition. Very lately, the revolving arms of the reaction-machine burst, (the internal pressure of the water amounts sometimes to 50 lbs per square inch,) and during the absence of these arms, which describe a circle of about 15 inches diameter, for repair, we have substituted the arms originally constructed by Messrs. *Ransomes*, which describe a circle of 20 inches diameter; and we think that, with full pressure of water, the motion is now free from some very minute inequalities which could be discovered with the smaller arms. The motion of this clock, in the combination of definiteness and smoothness, is probably the most perfect in existence.—A complete set of plans of the South-East Equatoreal has been prepared, under my instruction and under the more immediate superintendence of Mr. *Carpenter*, by an accomplished draftsman. But I have not had leisure for drawing up the letter-press explanation.—The *Barometers* and *Thermometers*, and all the minor instruments auxiliary to the principal instruments, are in efficient condition.—In our *Portable Altazimuth* it was found that the principal zenith-distance-level was too much concealed by the frame of the stand. I have had its position altered, so as to bring it fully into view.—The ancient instruments appear to be in their usual state. It will perhaps be desirable soon to clean and varnish the graduated limbs of Bradley's quadrants.—The question of dependence of the measurable amount of sidereal aberration upon the thickness of glass or other transparent material in the telescope (a question which involves, theoretically, one of the most delicate points in the Undulatory Theory of Light) has lately been agitated on the Continent with much earnestness. I have calculated the curvatures of the lenses of crown and flint glass (the flint being exterior) for correcting spherical and chromatic aberration in a telescope whose tube is filled with water, and have instructed Mr. *Simms* to proceed with the preparation of an instrument carrying such a telescope. I have not finally decided whether to rely on zenith-distances of γ Draconis or on right-ascensions of Polaris. In any form the experiment will probably be troublesome.

Among the ASTRONOMICAL OBSERVATIONS, it may be interesting to place on record that, on 1868, Nov. 20, 89 Herculis, a star of the 6th magnitude, N.P.D. 64°, was observed with the Transit-Circle when passing 1h 50m after the Sun; and, it would appear from the Assistant's report, was observed without difficulty.—Mr. Stone has attached to the South-East Equatoreal a thermo-multiplier, with the view of examining whether heat radiating from the principal stars can be made sensible in our instruments. The results hitherto obtained are encouraging, but they show clearly that it is vain to attempt this inquiry except in the most superb weather; and there has not been a night deserving that epithet for some months past. Mr. Carpenter has made, with the South-East Equatoreal, three drawings of the lunar spot Linnæus, three drawings of Jupiter, and two of Winnecke's Comet.

ON THE USE OF HIGH POWERS WITH REFLECTORS;

BY C. GROVER.

◆

In the *Astronomical Register* for January and March will be found a few remarks on the comparative merits of the achromatic and reflecting telescope. Since writing those, I have made a careful series of observations in order to ascertain how far a silvered glass reflector mounted by an amateur may be found useful with high powers, and thus raising the question of the relative merits of an amateur's work as compared with that of the professional optician. This is a question of the greatest importance, and it is obviously worth while to consider, when about to mount a reflector, what may reasonably be expected from it, and whether with the intended mounting it will be adapted for the class of observation for which it is intended to be used. The powers I had hitherto used ranged from 80 to 300, and about a couple of months back I acquired a new achromatic eye-piece of Mr. Browning's manufacture, giving a power of 450, or with the Barlow lens, of about 600. In order to give this a fair trial, I had the flat resilvered, and then tested the instrument upon a number of objects which I had previously well observed, and with the telescopic appearance of which I was well acquainted. The result of the experiment is certainly different from what I expected, for I find that although the mounting and adjustment of the instrument are sufficiently perfect for the accurate observation of celestial objects with powers up to 300, the application of such powers as 450 and 600 shows a sad want of that absolute firmness and stability of adjustment which characterise Mr. Browning's beautifully perfect instruments. I have carefully observed many double stars with powers from 100 to 600, and find that with powers up to 300 they are beautifully defined; but no manipulation, use of various stops or any other means clears up the confused image seen with higher powers. There is no distortion, so to speak, but a general haziness, or muddy outline, evidently the result of imperfect mounting, and not of any defect either in the mirror, plane, or eye-pieces.

I think it most important that this result should be brought under the notice of the readers of the *Register*, not only as a continuation of what I have already written on the subject, but in order to show what may reasonably be expected by an amateur when he mounts his own telescope. My experience goes to show that with a moderate degree of care and attention it is possible to mount a reflector sufficiently accurate for the ordinary requirements of any amateur, but if the instrument is intended for very delicate and difficult work, requiring high powers, and consequently, great stability, recourse must be had to the professional optician.

Town's End Road, Chesham: May 18, 1869.

LUNAR MONOGRAMS.—The Copies of Mr. Birt's monogram of the *Mare Serenitatis* being nearly exhausted, the Map is undergoing a careful revision. Observations of features not inserted in the map, if communicated to Mr. Birt, will meet with due attention. The reprint will contain a considerable number of additions.

ERRATA.—In No. 79, p. 158, line 50, for *Contrasts* read *Contrast*.—On p. 159, line 3, "Bird's double," (after ζ Cancri), should have commenced a principal line.—Line 19, for ξ Boötis, read ζ Boötis.—Line 36, (The "Crab"). For *With many stars* read *With* 87 *many stars*.—Line 46, *Gemini* should be *Gemin.*.—On p. 161, line 27, in "The same night on a faint star, *p*, the 7m. star *s* of Polaris," there should be no commas.—Line 49, for *reflectors* read *reflector*.

NOTICE.—In the present number of the *Register* the Tables of Occurrences, &c., for September are included. Nos. 81 and 82 are intended to be published at the commencement of October.

We are glad to say the Editor is recovering from his severe illness, but is unable to resume the management of the REGISTER at present.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

servers, has also added much valuable information as to the bright lines of the prominences since his first report. In the course of the session of the Royal Astronomical Society most of these discoveries have been more or less alluded to and discussed, but as the original observations have been exclusively recorded in the *Proceedings of the Royal Society*, we propose during the ensuing months to give, as occasion may serve, a condensed account of such recent solar spectroscopic observations abridged from the Journal above mentioned. Taking it for granted that the Report of MM. Janssen and Rayet which we translated at length in the *Astronomical Register*, and the papers read and the oral statements made at the Meetings of the Royal Astronomical Society have made our readers fully acquainted with the nature of the red flames and the existence of the *Chromosphere* or stratum of incandescent hydrogen surrounding the Sun, we find that the next communication in point of time is one from Mr. W. Huggins F.R.S., narrating his discovery of the method of viewing the red prominences without an Eclipse. It is dated February 16, 1869, and proceeds as follows :—

"Last Saturday, February 13, I succeeded in seeing a solar prominence so as to distinguish its form. A spectroscope was used, and a narrow slit was inserted after the train of prisms before the object-glass of the little telescope. This slit limited the light entering the telescope to that of the refrangibility of the part of the spectrum immediately about the bright line coincident with C.

The slit of the spectroscope was then widened sufficiently to admit the form of the prominence to be seen. The spectrum then became so impure that the prominence could not be distinguished. A great part of the light of the refrangibilities removed far from that of C was then absorbed by a piece of deep ruby glass. The prominence was then distinctly perceived."*

Mr. Huggins expressed the hope that he should be able to improve the method, which we believe he has done, but the precise mode has not yet been published.

During Mr. Lockyer's early observations he was much impressed with the changes which occurred, more especially in the form of the F line of his *Chromosphere*, and which suggested to him variations in the pressure and temperature of the gases enveloping the photosphere. To study these phenomena it became necessary to make experimental researches on gaseous spectra in the laboratory, and Mr. Lockyer was fortunate in being able for this purpose to obtain the assistance of Dr. Frankland F.R.S., so well known for his able contributions to chemical science. Working together, these gentlemen soon arrived at results which they embodied in a paper presented to the Royal Society last February, and which we proceed to extract:—

"1.—For some time past we have been engaged in a careful examination of the spectra of several gases and vapours under varying conditions of pressure and temperature, with a view to throw light upon the discoveries recently made, bearing upon the physical constitution of the Sun.

Although the investigations are by no means yet completed, we consider it desirable to lay at once before the Royal Society several broad conclusions at which we have already arrived.

---

* A drawing is given, by Mr. Huggins, shewing a triangular form connected by a narrow band with the Sun's limb.

It will be recollected that one of us in a recent communication to the Royal Society pointed out the following facts :—

i.—That there is a continuous envelope round the Sun, and that in the spectrum of this envelope (which has been named for accuracy of description the "chromosphere,") the hydrogen line in the green corresponding with Fraunhofer's line F takes the form of an arrow-head, and widens from the upper to the lower surface of the chromosphere.

ii.—That ordinarily in a prominence the F line is nearly the same thickness as the C line.

iii.—That sometimes in a prominence the F line is exceedingly brilliant, and widens out so as to present a bulbous appearance above the chromosphere.

iv.—That the F line in the chromosphere, and also the C line, extend on to the spectrum of the subjacent regions, and re-reverse the Fraunhofer lines.

v.—That there is a line near D visible in the spectrum of the chromosphere, to which there is no corresponding Fraunhofer line.

vi.—That there are many bright lines visible in the ordinary solar spectrum near the Sun's edge.

vii.—That a new line sometimes makes its appearance in the chromosphere.

2.—It became obviously, then, of primary importance—

i.—To study the hydrogen spectrum very carefully under varying conditions, with the view of detecting whether or not there existed a line in the orange, and

ii.—To determine the cause to which the thickening of the F line is due.

We have altogether failed to detect any line in the hydrogen spectrum in the place indicated, i.e. near the line D, but we have not yet completed all the experiments we had proposed to ourselves.

With regard to the thickening of the F line, we may remark that, in the paper by MM. Plücker and Hittorf, to which reference was made in the communication before alluded to, the phenomena of the expansion of the spectral lines of hydrogen are fully stated, but the cause of the phenomena is left undetermined.

We have convinced ourselves that this widening out is due to pressure, and not appreciably, if at all, to temperature *per se.*

3.—Having determined, then, that the phenomena presented by the F line were phenomena depending upon and vindicating varying pressures, we were in a position to determine the atmospheric pressure operating in a prominence, in which the red and green lines are nearly of equal width, and in the chromosphere, through which the green line gradually expands as the Sun is approached.*

With regard to the higher prominences, we have ample evidence that the gaseous medium of which they are composed exists in a condition of *excessive* tenuity, and that at the lower surface of the chromosphere itself the pressure is very far below the pressure of the earth's atmosphere.

The bulbous appearance of the F line before referred to, may be taken to indicate violent connective currents or local generations of heat, the condition of the chromosphere being doubtless one of the most intense action.

4.—We will now return for one moment to the hydrogen spectrum. We have already stated that certain proposed experiments have not been carried out. We have postponed them in consequence of a further consideration of the fact that the bright line near D has apparently no representative among the Fraunhofer lines. This fact implies that, assuming the line to be a hydrogen line, the selective absorption of the chromosphere is insufficient to reverse the spectrum.

It is to be remembered that the stratum of incandescent gas which is pierced by the line of sight along the Sun's limb, the radiation from which stratum gives us the spectrum of the chromosphere, is very great compared with the radial thickness of the chromosphere itself; it would amount to something under 200,000 miles close to the limb.

---

* Will not this enable us ultimately to determine the temperature?

Although there is another possible explanation of the non-reversal of the D line, we reserve our remarks on the subject (with which the visiiblity of the prominences on the Sun's disk is connected) until further experiments and observations have been made.

5.—We believe that the determination of the above-mentioned facts leads us necessarily to several important modifications of the received theory of the physical constitution of our central luminary—the theory we owe to Kirchhoff, who based it upon his examination of the solar spectrum. According to this hypothesis, the photosphere itself is either solid or liquid, and it is surrounded by an atmosphere composed of gases and the vapours of the substances incandescent in the photosphere. We find, however, instead of this compound atmosphere, one which gives us nearly, or at all events mainly, the spectrum of hydrogen: (it is not however, composed necessarily of hydrogen alone; and this point is engaging our special attention); and the tenuity of this incandescent atmosphere is such, that it is extremely improbable that any considerable atmosphere, such as the corona has been imagined to indicate, lies outside it, a view strengthened by the fact that the chromosphere bright lines present no appearance of absorption, and that its physical conditions are not statical.

With regard to the photosphere itself, so far from being either a solid surface or a liquid ocean, that it is cloudy, or gaseous, or both, follows both from our observations and experiments. The separate prior observations of both of us have shown—

i.—That a gaseous condition of the photosphere is quite consistent with its continuous spectrum. The possibility of this condition has also been suggested by Messrs. De la Rue, Stewart, and Loewy.

ii.—That the spectrum of the photosphere contains bright lines where the limb is observed, these bright lines indicating probably an outer shell of the photosphere of a gaseous nature.

iii.—That a Sun-spot is a region of greater absorption.

iv.—That occasionally photospheric matter appears to be injected into the chromosphere.

May not these facts indicate that the absorption to which the reversal of the spectrum and the Fraunhofer lines are due, takes place in the photosphere itself or extremely near to it, instead of in an extensive outer absorbing atmosphere? And is not this conclusion strengthened by the consideration that otherwise the newly-discovered bright lines in the solar spectrum itself should be themselves reversed on Kirchhoff's theory? this, however, is not the case. We do not forget that the selective radiation of the chromosphere does not necessarily indicate the whole of its possible selective absorption, but our experiments lead us to believe that, were any considerable quantity of metallic vapours present, their bright spectra would not be entirely invisible in all strata of the chromosphere."

It will be seen that the authors of this paper are led to a conclusion of the greatest importance; namely, that the theory of Kirchhoff must be modified to the extent of giving up, wholly, or nearly so, the notion of an extensive atmosphere surrounding the photosphere, (and apparently evidenced by the corona,) to which he attributed the absorptive action producing the Fraunhofer lines. The statement that a gaseous condition of the photosphere may produce a continuous spectrum is also at variance with Kirchhoff's experiments, and requires that the evidence on these two points should be most conclusive in its character before the views referred to are adopted.

(To be continued.)

CORRESPONDENCE.

N. B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

THE NUCLEUS OF COMETS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—If we assume the views expressed in my letters on comets to be correct, viz. "that space contains masses of nebulous matter, scattered here and there, at different distances, but far closer together than the fixed stars; thousands perhaps, existing between our system and any of them: and that any of those nebulous masses, when attracted by the Sun into our system, becomes a comet"—it may be asked, what then composes the comet's nucleus? Let me attempt to answer this question. It is not likely that all nebulæ, when first attracted by the sun, will have undergone the same amount of condensation; some may be perfectly gaseous, like the nebula of Orion, others may have a portion more condensed than the rest of their mass, and it is even possible, as Mr. Lockyer states, (in his excellent little work *Elementary Astronomy*, quoting Arago, I think,) that some comets may exist, which are solid bodies, having no nebulous atmosphere at all. The more numerous class however, are evidently gaseous; I believe every one yet examined by Mr. Huggins with the spectroscope gives bright lines, and are almost certainly gas. Let us enquire first, what constitutes the nucleus in this class.

A comet being an elongated mass of nebulous matter, with its longer axis directed toward the Sun, the rays will become visible by contact with the particles of cometic matter. This diagram may help us (see diagram.) The dotted lines represent the Sun's rays, in vacuum, and of course invisible; those rays strike on the comet's mass, and are refracted, (as light always is on entering a denser medium,) coming to a focus about A. The ray B will be refracted when entering the comet, and pass out of it at C, where it will again become invisible. All the other rays will be more or less refracted, and cross each other at about the same point, at the focus of the ellipse or parabola, nearly all the light will be concentrated here, and this part will be much brighter than any other part of the comet. This blaze of light then is the comet's nucleus in gaseous comets; and will better accord with the facts noticed by Webb and others than any other view with which I am acquainted. He says that Herschel II. saw a group of 16th and 17th magnitude stars through the heart of Biela's comet in 1832; that high powers usually dissolve any apparent solidity; that different instruments give different sizes to what look like planetary disks. Those facts cannot be explained by a solid nucleus, but one composed of rays of light concentrated at that point, will, so far as I am aware, meet all the facts of the case. An inspection of the diagram will show that the whole mass will be illuminated to some extent, and as the rays are thrown out at the sides by refraction, we may expect a dark space to exist in the center of the tail, and even in this class of comet, it is probable that a violent action must take place at the nucleus, or in other words, in the center of refracted solar rays, and though it is possible the whole cometic mass may be white hot, yet it may be heated to a higher degree, and thus expanded in the comet's focus. In this class of comets then, nuclei are nothing more than solar light condensed by refraction at that point.

But if the nebulous matter should have so far condensed before the Sun approached sufficiently near to influence it and draw it to itself, as to have solid matter formed at its center, it is evident, that this solid mass would not be elongated by centrifugal force, as the gaseous or vapoury matter surrounding it would. The gaseous matter, which we may call its atmosphere, would fly off from, and fall behind the solid portion; and in this case the solid portion would become in fact the nucleus of the comet. As the comet approached the Sun, heat must be concentrated by the refraction of solar rays in their passage through the atmosphere preceding the nucleus, which, being thus placed in the intense heat of the condensed solar rays, would, in all probability, be converted into gas. I watched Donati's Comet with much attention, and suspect it belongs to this class, but my instrumental means were at that time very inferior. The drawings of Dawes, Lassell, Bond, and others, look strongly in this direction, but I much think this solid mass was all converted into gas before the large drawing of the head in Bond's splendid work was made. This is so perfectly like what we might expect from refracted rays by a comet wholly gaseous, that we might regard it as prepared to illustrate the former part of this paper. I am sorry I cannot reproduce it here.

If this conjecture be correct, that the comet had a solid nucleus when it entered our system in 1858, I should be inclined to think that it was the first visit of that comet to our system, and if so, it would have entered our system from that part of the heavens toward which the sun is moving; and, after its perihelion passage, would go out in the same direction into space. Of course, I do not mean to the exact point, but somewhere near, not above 30° or 40° from π Herculis. I have no means at hand of testing this conjecture; perhaps some one of your readers will kindly give me the facts.

If the visit of 1858 was the first visit, it is possible that at its next return, it may be purely gas or vapour; the time required for it to return to the Sun may not be sufficient to permit it to condense into a solid. Our descendants may test this question, most likely we may not.

But whether the nucleus be solid or gaseous, the gaseous part of the comet, which is immensely larger than any solid nucleus, will be governed by the same laws with which comets wholly gaseous are governed.

In closing, I would say that it is by no means needful for us to suppose that the visible portion of a comet should be of the same form as the mass of cometary matter: the fact that the light will be condensed and then scattered by refraction will almost certainly cause some parts of the mass to be invisible, unless the mass be self-luminous; and even in that case, that portion which is lighted by sunlight will be so much brighter than others, that careful observers only would be likely to notice it; and it would be more difficult still to represent it correctly on paper: as Mr. Chambers observes, "it is difficult to prevent the best artists from exaggerating details," and the comparison of ordinary drawings of comets with the splendid and accurate drawings in Bond's work on Donati's Comet will clearly prove this point.

The visible portion of the comet will be the portion where the solar rays strike on the comet's matter, and this light must pass outward on the extended radius-vector, or the line passing from the Sun through the comet's head. No matter what the shape of the mass, the tail will have much the same form, but by no means the same size or length; and some comets may throw the focus so far back that it will be near the outside of the comet's body, and then it can have very little tail, or none at all. Encke's Comet is of this kind, at least such is my opinion.

I am, Sir,
Truly yours,
A. ELVINS.

Mr. PENROSE ON OCCULTATIONS.

Sir,—May I be excused in adverting to the kind notice of my book on Occultations &c., in the ASTRONOMICAL REGISTER of this month, and for which I am much obliged. There is, however, one point which I should be glad if it could be mentioned, (should you be disposed to return to the subject); viz., that besides the Predictions and *Approximate* Graphical Constructions for Reduction, there is is a chapter on the *Rigorous* Reduc-

tion, by means of calculation only, of an observed Occultation or Eclipse, which might, perhaps, be thought of more value than the Predictions &c., by those of your readers who are within the range of the Predictions given in the Nautical Almanac &c.

Colebyfield, Wimbledon: **Yours faithfully,**
August 9, 1869. **F. C. PENROSE.**

Table of Velocities of Celestial and Terrestrial Bodies and Phenomena.

BY G. J. WALKER.

CELESTIAL BODIES &c.	Feet in one second.	Scale 10 miles to an inch.	AUTHORITIES.
		In.	
Proper motion of irregular spots on Jupiter	6	$\frac{1}{8800}$	Beer and Mädler; Guillemin, 'The Heavens,' p. 231
Gentle breeze	6–7		Thomson, Meteorology, p. 378
Gulf Stream, Strait of Florida (near the Azores 8½ inches in one second)	8½		English Cyclopædia, article "Atlantic Ocean."
Comet of 1680 at aphelion	10	$\frac{1}{5280}$	Humboldt, Cosmos i. p. 102
Rapid river Moderate wind Horse trots	10½		Lardner. Handbook of Natural Philosophy, 1. p. 62
Tidal Wave, London to Richmond	19	$\frac{1}{2780}$	Whewell; Lardner, 3. p. 228
Carrier Pigeon, probable maximum velocity (42 miles an hour)	61½		English Cyclopædia, Natural History, article "Flying."
Celebrated race-horse "Eclipse," at its greatest speed	62½		Do. do. " "Locomotion of animals."
Solar Spot observed by Mayer closed up at the rate of	65		Lardner, 3. p. 236
Descent of balloon with Messrs. Coxwell and Glaisher, July 17th, 1862	65		Exeter Hall Lecture by Glaisher, p. 30
Express train, 45 miles an hour	66	$\frac{1}{800}$	
Comet of 1843 at aphelion	70 (?)	$\frac{1}{750}$	Hind, Comet of 1556. p. 55
Hurricane	73–88		Thomson, Meteorology, p. 378
Falcon which belonged to Henry IV of France, from Fontainebleau to Malta (1350 miles) in 24 hours, on the supposition (improbable) that it was on the wing the whole time	82½		Chambers' Encyclopædia, article 'Falcon;' Barnes, Commentary on Job, ch. XXXIX
Railway express, 60 miles an hour	88	$\frac{1}{600}$	
Ostrich, probable speed at first setting out, not less than	88		Chambers' Encyclopædia, article 'Ostrich'
Violent hurricane	117–147		Thomson, Meteorology, p. 378
Donati's Comet, (1858) at aphelion	320	$\frac{1}{165}$	Arago on Comets, English Translation, p. 162

CELESTIAL BODIES &c.	Feet in one second.	Scale 10 miles to an inch	AUTHORITIES.
Proper motion of Solar spot observed by Laugier	363	$\frac{1}{145}$	Guillemin, p. 37
Place at the latitude of Paris by the Earth's rotation	999	$\frac{1}{53}$	Do. p. 110
Tidal Wave in the Atlantic	1030		Lardner, 3. p. 228
Comet of 1556 at aphelion	1100	$\frac{1}{48}$	Hind, Comet of 1556. p. 55
Earthquakes, least velocity	1100		Herschel, Familiar lectures, p. 16
Sound, barometer 29·8, thermometer 61°	1118		Lardner, 1. p. 461
Tidal Wave, West Coast of South America	1250	$\frac{1}{42}$	Loomis, Treatise on Astronomy, p. 189
Stones from Mount Etna in eruption	1250		Peters ; Humboldt, Cosmos, i. XXVI. note
Point on the Earth's Equator	1526	$\frac{1}{35}$	Chambers, Descriptive Astronomy, p. 756
32 Pounder 58 cwt. Cannon, smooth bore, initial velocity of ball	1690	$\frac{1}{31}$	Journal of United Service Institution, Nos. XXII and XXIII, 1862
12 Pounder 18 cwt. Cannon, smooth bore, initial velocity of ball	1770		" " "
Moon's shadow over the Earth in a Solar Eclipse, where it falls perpendicularly	3000	$\frac{1}{18}$	Loomis, p. 168
Moon in her orbit	3370	$\frac{1}{16}$	Denison, 'Astronomy without Mathematics'
Propagation of sound in water	4767	$\frac{1}{11}$	Lardner, 1. p. 466
Shadow of the Eclipse of 1715 passed over England at the rate of	5192	$\frac{1}{10}$	Halley ; Grant's History of Physical Astronomy, p. 376, note
	Miles in 1 sec.	In.	
Point on Sun's Equator	$1\frac{1}{4}$	$\frac{1}{8}$	Guillemin, p. 32
Earthquakes, Greatest velocity	$1\frac{1}{3}$		Herschel, Familiar Lectures, p. 16
Polaris, proper motion in space	$1\frac{1}{2}$	$\frac{1}{7}$	Guillemin, p. 345
61 Cygni, movement of each star round the common centre of gravity	$1\frac{9}{10}$	$\frac{1}{5}$	" p. 352
Iapetus round Saturn	2		Proctor, 'Saturn and its System'
Oberon round Uranus	2		Chambers, p. 153
Propagation of sound in iron	$2\frac{1}{5}$		Herschel, Familiar Lectures, p. 16
α Centauri, movement of each star round the common centre of gravity	$2\frac{3}{5}$	$\frac{1}{4}$	Guillemin, p. 352
Neptune's Satellite round the planet	$2\frac{7}{10}$	$\frac{7}{25}$	Chambers p. 161
Neptune in its orbit	$3\frac{3}{10}$	$\frac{1}{3}$	Denison
Titan round Saturn	$3\frac{1}{2}$		Proctor
Ariel round Uranus	$3\frac{1}{2}$		Chambers, p. 153
Uranus in its orbit	$4\frac{1}{5}$	$\frac{2}{5}$	Denison

CELESTIAL BODIES &c.	Miles in one second	Scale 10 miles to an inch	AUTHORITIES.
Solar system in space	$4\frac{7}{10}$	$\frac{12}{25}$	Chambers, p. 494
Fourth Satellite of Jupiter round the planet	$5\frac{1}{10}$	$\frac{1}{2}$	Denison
Meteoric body supposed by M. Petit to revolve round the Earth	$5\frac{1}{5}$		Herschel, Outlines, p. 663, 5th Edition
Saturn in its orbit	$5\frac{3}{5}$	$\frac{14}{25}$	Denison
Point on Saturn's equator	6	$\frac{3}{5}$	Proctor
Second Satellite of Jupiter round the planet	$6\frac{1}{2}$		Denison
Third Satellite of Jupiter	$6\frac{4}{5}$	$\frac{17}{25}$	Do.
Point on Jupiter's equator	$7\frac{7}{10}$		Do.
Jupiter in its orbit	8	$\frac{4}{5}$	Do.
Mimas round Saturn	$8\frac{9}{10}$	$\frac{9}{10}$	Proctor
Cybele in its orbit	$9\frac{2}{5}$		Chambers, p. 98
First Satellite of Jupiter round the planet	$10\frac{9}{10}$	$1\frac{1}{10}$	Denison
The Minor Planets (mean)	11		
Flora in its orbit	$12\frac{3}{10}$		Chambers, p. 98
a Lyræ (Vega), motion in space	13	$1\frac{3}{10}$	Guillemin, p. 345
a Centauri " "	13		" "
Sirius " "	14	$1\frac{2}{5}$	" "
Mars in its orbit	$14\frac{7}{10}$		Denison
The Earth in its orbit	$18\frac{1}{5}$	$1\frac{4}{5}$	Do.
Venus in its orbit	$21\frac{3}{5}$	$2\frac{4}{25}$	Do.
Mercury in its orbit	$29\frac{1}{5}$	$2\frac{9}{10}$	Do.
Capella, motion in space	30	3	Guillemin, p. 345
Meteors, average	34	$3\frac{2}{5}$	A. Herschel, Guillemin p. 194
Comet of 1858 (Donati) at perihelion	35	$3\frac{1}{2}$	Arago on Comets, p. 162
61 Cygni, motion in space	40	4	Guillemin, p. 345
Some meteors	43-50		" p. 194
Arcturus, motion in space	54	$5\frac{2}{5}$	" p. 345
Some meteors	100	10	" p. 194
Comet of 1811, development of tail	104	$10\frac{2}{5}$	Loomis, p. 261
Comet of 1843, average development of tail in 20 days	116	$11\frac{3}{5}$	Lardner, 'Museum of Science and Art, 2, p. 71
Motion of luminous spot on the Sun, observed by Messrs. Carrington and Hodgson, Sept. 1, 1859	117	$11\frac{7}{10}$	Herschel, Familiar Lectures, p. 80
Comet of 1556 at perihelion	119	$11\frac{9}{10}$	Hind, Comet of 1556, p. 55
Comet of 1858 (Donati), increase of tail from Oct. 5 to Oct. 6, (12,000,000 miles)	139	$13\frac{9}{10}$	Chambers, p. 305
Comet of 1680 at perihelion	333	$33\frac{3}{10}$	Herschel, Familiar Lectures, p. 109
Comet of 1680, increase of tail after perihelion	347	$34\frac{7}{10}$	Herschel, 'Outlines,' p. 378, 5th Edition
Comet of 1843 at perihelion	366	$36\frac{3}{5}$	" " p. 401
Comet of 1843, increase of tail after perihelion	405	$40\frac{1}{2}$	Loomis, p. 261

CELESTIAL BODIES &c.	Miles in one second	Scale 10 miles to an inch	AUTHORITIES.
Electric discharge on iron telegraphic wires	16000	133	Professor Walker, U.S.
" " "	28500	238	Professor Mitchell, Cincinnati
" " "	62000	517	MM. Fizeau and Gonelle
Electric discharge on copper wire	112680	939	MM. Fizeau and Gonelle Lardner, 'Museum,' 3, p. 176
Light	186000	1550	Herschel, Familiar Lectures, p. 234
Electric discharge on copper wire	288000	2400	Professor Wheatstone, Lardner, 'Museum,' 3. p. 176, and English Cyclopædia, article '*Electricity*'
Gravitation	(?)		See Herschel, 'Familiar Lectures,' p. 90

It is sometimes convenient to be able to ascertain and compare velocities without the trouble of searching various books. The scale, approximately given in the above table, is intended to assist the mind in endeavouring to realize comparative velocities. In Lardner's 'Museum of Science and Art,' vol. 6, p. 72, is a minute white circle, $\frac{1}{180}$ of an inch in diameter, easily visible as a point on a dark ground. This may be taken as a probable limit of unassisted vision. On page 69 is a diagram of bands of parallel lines, 128 to an inch. Average eyes can see lines of a band containing 150 to an inch, (p. 72.) The first seventeen velocities above specified would therefore be invisible without a microscope, if laid down on the assumed scale.

Leaving out the propagation of light and electricity, and the emission of the matter composing the tails of comets, the greatest known velocity of a body in space is that of the comet of 1843 at perihelion. The greatest contrasting velocities of any one body are those of the great comet of 1680, at aphelion and perihelion.

Mr. Denison (p. 90) notices the curious result following from the near equality of Jupiter's motion in its orbit, and the rotating velocity of a point on his equator. At noon, or when he is just opposite the Sun, that point would be carried nearly as much backwards by the rotation as forwards by the orbital motion of the planet, and would therefore nearly stand still for the time in space, but for the motion of the whole Solar System.

GEORGE J. WALKER.

Reasons for concluding that an Astronomical Date may be assigned to the Temple at Stonehenge.

◆

It was ever of old the desire of Temple builders that posterity should by some means, be informed as to the period when the foundation of their edifice was laid, or its chief entrance erected. The desire continues to this day in the erection of our public buildings, by a coin of the realm and reign being placed under the foundation-stone.

The ancient Egyptian Temple builders made use of *Astronomy* to convey the date of their buildings. Professor Piazzi Smyth, with others, including the author of "Mazzaroth" say, that they fixed the grand entrance of their temples according to the ascension of the star Sirius. It is well known that the Druids were through the Phœnicians of Egyptian extraction, and, among other sciences, taught astronomy, in which they attained great proficiency.

That the Druids knew of the Sun's solstices, the inclined astronomical stone marked A in the plan of Stonehenge shows; the Sun, on the 21st of June as it may be seen, rises exactly over that stone, proceeding over the stone marked B on the entrance of the trench, passing with equal exactitude over the principal Eastern entrance, the central and wider aperture, marked C, and also over the centre of the great sacrificial stone, marked D.

The star Sirius, immersed in the Sun's beams, was anciently regarded as connected with that luminary's rising. The builders of Stonehenge may have had a double object in placing the grand entrance of their temple as it is 6 degrees N.E. First to mark the *season* of its erection, being summer, as the Sun on the 21st of June passes over the Astronomical Stone.

Secondly, the *year* of erection, i.e., that period when Sirius ascended over the same astronomical stone, taking a like course as the Sun, over the grand entrance, and over the centre of the altar, or grand sacrificial stone.

It may be assumed that the first object of *Season* date is established, by the fact, that the Sun on the 21st of June does actually rise directly over the Astronomical Stone.

As a connection anciently, was thought to exist between the rising of the Sun and the rising of Sirius, it may not be mere conjecture, when it is attempted to prove that the *year* date of the temple at Stonehenge can be ascertained by astronomy, that science having ever borne a part in the placing of the chancels of ecclesiastical buildings towards the rising of the Sun. And it may not be affirming too much, that the germ of our system of ecclesiastical architecture may date back to Stonehenge. In order to discover, whether, like the ancient Egyptians, the Druids determined the Astronomical Stone and the entrance of their temple at Stonehenge by the ascension of Sirius, we must trace back the precession of the equinoxes to the degree when the ascension corresponded with the position of the astronomical stone, and east entrance of Stonehenge. The present position of Sirius is 40° from 6° N.E., the position of the grand entrance of Stonehenge. It is ascertained that 71 years 2 months must be allowed to each degree. Thus

$$\begin{array}{rl} & 40^\circ \\ & 71 \\ \hline & 40 \\ & 280 \\ \hline & 2840 \\ & 6{\cdot}8 \\ \hline & 2846{\cdot}8 \\ \text{A.D.} & 1869 \\ \hline & 977{\cdot}8 \end{array} \qquad \begin{array}{l} 40^\circ \\ 2 \\ \hline 80 \text{ mos., or 6 yrs. 8 mos.} \end{array}$$

977·8 Date of erection of Stonehenge.

About the time of the revolt of the 10 tribes under Rehoboam, king of Israel, according to Manby Power in his history of the kings of ancient Britain, (Simpkin & Marshall) king Efroc was reigning over Britain, the kingdom to which King Lear 138 years later succeeded, great grandson of Efroc. It was in Efroc's reign that the city of York was founded, called York after his name.

The Druids in their construction of Stonehenge displayed their knowledge of astronomy. The stone on the south side of the trench, marked E on the plan, they have so placed, as to point to the Sun's rise in the winter solstice, the north stone, marked F, pointing to the setting in the summer solstice, and from the priests station before the altar marked D, the entrance of the Sun into the 12 signs of the zodiac can be seen through the apertures of the Eastern circular pillars. Such knowledge as this implies their acquaintance with the use of the compass in obtaining the cardinal points and determining the degrees. It is said the magnet they used was named by them "Lapis Heracleus," a noteworthy coincidence. Hercules, as is well known, was the chief deity of the Phœnicians. There may be more of a Phœnician element in some of the sciences handed down to us Englishmen than many at present are willing to allow.

ROTATION AND REVOLUTION.

BY A LOOKER-ON.

◆

Perigal and his coadjutors treat rotation as a particular mode of turning round. They affirm that a body rotates, when it turns round its own axis or center of gravity, and that it does not rotate unless it turns round its own axis or center: turning round any other center being revolution. Accordingly, they consider rotation to be the limit of revolution, and and revolution to be an extension of rotation.

Those who imagine that the Moon rotates while revolving round the Earth, assert that a body rotates if it turns round to all points of the compass; and that a body does not rotate unless it turns round to all points of the compass—whatever other movements it may have.

Thus it would seem that Perigal & Co. consider rotation and revolution to be different *actions* of turning round: and the theorists treat rotation as the *effect* of turning round, using the terms rotation and revolution almost indiscriminately to express the action of turning round.

Let us now test the relative applicability of these (so-called) definitions to a few simple motions—alluding (for distinction) to P. & Co. as Copernicans, and to the theorists as Galileans, or followers of Galileo, who seems to have originated the notion that a body moving in a circular orbit maintains its parallelism without any additional motion, either of rotation, or of a second revolution. This dictum of Galileo is the doctrine impugned in the Moon Controversy.

When the fly-wheel of a machine is set in motion, both Copernicans and Galileans would say that it rotates, the C., because it turns round its own center or axis; and the G., because it turns all round to all points of the compass: bût if the G. speak of it as revolving rapidly, the C. would not object to the terms, because, although it rotates as a *whole*, yet every *individual* part of it, the spokes and rim for instance, all revolve round the common center of the wheel. Similarly, the C. would say that a grindstone rotates: but that every little particle of grit composing it revolves round the common center: while the G. assert that not only does the grindstone revolve as a whole, but that every component bit of grit not only rotates round its own center, (the bit of grit's center,) but that each bit of grit at the same time revolves round the center of every other bit of grit!

Similarly, the C. and G. would say that an opera-dancer rotates when performing a pirouette; and that soldiers rotate when they "right about face" or "left about face." But when soldiers "wheel" round, the C. would say that they revolve only; while the G. would say that they rotate as well as revolve, because they turn round to all points of the compass. The C. explain that this orbital rotation is the effect consequent upon their revolution round the pivot-man, who alone rotates, (and he only on occasions when he turns round without leaving the spot upon which he stood before, during and after wheeling): and they confirm this assertion by the fact that in "right or left face" each soldier turns round to his comrades as well as to all points of the compass; while in wheelig they do not turn round to each other, although they turn round to all points of the compass, and to the spectators around them.

When a rider sits astride a horse, it is obvious that he cannot turn round his own axis, or be turned round his own axis, unless the horse turns round under him. If he stand on the horse's back he may pirouette on the saddle, turning either to the right or left as often as he pleases: in this turning round his own axis, he will turn round to all points of the compass, he will turn round to the horse, and he will turn round to all the spectators in the ring, and in the boxes and gallery. In this case, both the C. and G. would say he rotates. Let him, however, canter round the ring astride the horse, when the G. will say he rotates as well as revolves, because he turns round to all points of the compass. To this the C. would object, affirming that he does not rotate, because he does not turn round on the horse, or to the spectators *within* the ring: while his turning round to the spectators in the boxes and elsewhere outside the ring is the consequence of his revolving round the center of the ring, and of their being situated outside his orbit. The C. say he has but one single motion, a revolution only; but the G. say he has a double motion, rotation in addition to revolution.

Again, standing on the saddle while cantering round the ring, the rider could easily avoid turning his back to the Queen, were she in one of the boxes, by turning round his axis in the contrary diretion to that in which he is riding—by turning round his axis from right to left, while cantering from left to right, or vice versâ. In this case the G. would say that he has but one motion, revolution, and does not rotate, because he does not turn round to all points of the compass: the C. would say that he has two movements, rotation as well as revolution, because he turns round to the horse, and to the spectators within the ring and therefore inside his orbit; explaining that he does not turn round to the Queen and others outside his orbit, because the two movements mutually counteract each other, the rotation round his axis turning him in one direction exactly as much as the orbital revolution turns him round in the opposite direction, so neutralizing each other, and producing what is called parallel circular motion.

THE PLANETS FOR OCTOBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension			Declination		Diameter	Meridian Passage	
		h	m	s	°	′		h	m
Mercury	5th	14	7	40	− 16	35½	8"·1	1	10·7
	20th	13	33	57	10	39	9"·8	23	34·1
Venus	5th	15	11	18	− 19	2	14"·3	2	14·2
	20th	16	25	12	23	38	15"·4	2	28·9
Jupiter	5th	3	11	6	+ 16	27½	44"·6	14	12·0
	20th	3	4	55	16	1½	45"·8	13	6·8
Neptune	5th	1	10	12	+ 5	36½	—	12	11·3
	20th	1	8	40	5	27	—	11	10·9

ASTRONOMICAL OCCURRENCES FOR OCTOBER, 1869.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Neptune. —
Frid	1		Sidereal Time at Mean Noon, 12 41 1·3			12 27·5
Sat.	2		Meridian Passage of the Sun, 10m 44s before Mean Noon	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	11 2 12 51 13 23 15 5	12 23·5
Sun	3			3rd Sh. I. „ Sh. E. „ Tr. I. „ Tr. E.	10 48 12 54 14 34 16 3	12 19·4
Mon	4			2nd Oc. R. 1st Sh. I. „ Tr. I. „ Sh. E.	10 9 15 35 16 26 17 47	12 15·4
Tues	5	2 19 19 33 22 32	● New Moon Conjunction of Venus and ι¹ Libræ (10m·0) W. Conjunction of Mars and Venus 0° 38′ S.	1st Ec. D. „ Oc. R.	12 45 7 15 43	12 11·3
Wed	6	10 23	Conjunction of Moon and Mercury 9° 2′ S.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	10 3 10 52 12 15 13 3	12 7·3
Thur	7	16 9 17 42	Conjunction of Moon and Mars 5° 38′ S. Conjunction of Moon and Venus 6° 20′ S.	1st Ec. D. „ Oc. R.	7 13 43 10 10	12 3·2
Fri	8	6 29	Near approach of Moon to 49 Libræ (5½)	1st Sh. E. „ Tr. E.	6 44 7 29	11 59·2
Sat	9	4 3	Conjunction of Moon and Saturn 2° 39′ S.	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	13 38 15 9 15 59 17 23	11 55·1
Sun	10			3rd Sh. I. „ Sh. E. „ Tr. I.	14 49 16 54 17 58	Moon. — 4 28·0
Mon	11	5 14 6 8 6 50 22 2	Occultation, 31 Sagittarii Reappearance of do. (6) Near approach of Moon to 33 Sagittarii (6) ☽ Moon's First Quarter	2nd Ec. D. „ Oc. R. 1st Sh. I. „ Tr. I.	8 48 16 12 26 17 29 18 11	5 22·4
Tues	12			1st Ec. D. „ Oc. R.	14 39 29 17 28	6 15·0
Wed	13		Illuminated portion of disk of Venus=0·734 of Mars=0·959	2nd Tr. E. 1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	6 32 11 58 12 37 14 10 14 48	7 5·3
Thur	14	19 20	Conjunction of Venus and δ Scorpii (6m·1) W.	3rd Ec. R. „ Oc. D. „ Oc. R. 1st Ec. D. „ Oc. R.	6 33 48 7 27 8 56 9 8 8 11 55	7 53·0

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Fri	15	9 23	Near approach of Moon to 50 Aquarii (6)	1st Sh. I. ,, Tr. I. ,, Sh. E. ,, Tr. E.	6 26 7 3 8 38 9 14	Moon. — 8 38·4
Sat	16	 12 43 13 22	Sidereal Time at Mean Noon 13 40 9·6 Occultation, ψ^1 Aquarii Reappearance of do. (4½)	1st Oc. R. 2nd Sh. I. ,, Tr. I.	6 21 16 15 17 26	9 21·9
Sun	17		Meridian Passage of the Sun, 14m 38s before Mean Noon			10 4·2
Mon	18	2 24 14 51	Conjunction of Venus and ρ Ophiuchi (2m·7) E. Conjunction of Venus and ρ Ophiuchi 0° 8′ N.	2nd Ec. D. ,, Oc. R.	11 23 51 14 41	10 45·7
Tues	19	20 56	Inferior Conjunction of Mercury	1st Ec. D.	16 34	11 27·3
Wed	20	1 57	○ Full Moon	2nd Tr. I. ,, Sh. E. ,, Tr. E. 1st Sh. I. ,, Tr. I. ,, Sh. E. ,, Tr. E.	6 33 7 54 8 48 13 52 14 21 16 4 16 32	12 9·6
Thur	21	17 34	Conjunction of Moon and Jupiter 3° 40′ N.	3rd Ec. D. ,, Ec. R. ,, Oc. D. 1st Ec. D. 3rd Oc. R. 1st Oc. R.	8 46 32 10 35 7 10 45 11 2 41 12 16 13 39	Neptune. — 11 6·8
Fri	22		Saturn's Ring: Major Axis=35″·13 Minor Axis=15″·82	1st Sh. I. ,, Tr. I. ,, Sh. E. ,, Tr. E.	8 21 8 47 10 33 10 58	11 2·7
Sat	23			1st Ec D. ,, Oc. R.	5 31 17 8 5	10 58·7
Sun	24			1st Tr. E.	5 24	10 54·7
Mon	25	12 0 12 54 12 25 13 22 14 7	Occultation, 16 Geminorum (6) Reappearance Occultation, ν Geminorum Reappearance of do. (4½) Conjunction of Saturn and Venus 3° 31′ S.	2nd Ec. D. ,, Oc. R.	13 59 24 16 56	10 50·6
Tues	26	11 35 21 43	Near approach of Moon to 56 Geminorum (5½) Conjunction of Moon and Uranus 1° 24′ N.	1st Ec. D.	18 28 39	10 46·6
Wed	27	18 35 20 34	Near approach of Moon to θ Canceri (6) ☾ Moon's Last Quarter	2nd Sh. I. ,, Tr. I. ,, Sh. E. ,, Tr. E. 1st Sh. I. ,, Tr. I. ,, Sh. E. ,, Tr. E.	8 10 8 49 10 31 11 3 15 46 16 5 17 58 18 15	10 42·5
Thur	28			3rd Ec. D. 1st Ec. D. ,, Oc. R. 3rd Oc. R.	12 47 49 12 57 22 15 23 15 34	10 38·5

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Fri	29			2nd Oc. R. 1st Sh. I. " Tr. I. " Sh. E. " Tr. E.	6 2 10 15 10 31 12 27 12 41	Neptune. 10 34·4
Sat	30			1st Ec. D. " Oc. R.	7 26 1 9 48	10 30·4
Sun	31			1st Tr. I. " Sh. E. " Tr. E.	4 57 6 56 7 7	10 26·3

THE TRANSIT OF VENUS IN 1874.—It is with great satisfaction we observe that the Government of this country is not unmindful of the importance of upholding our scientific reputation on the occasion of the coming Transits. All the great nations of Europe and our American brethren will probably be represented by expeditions for observing these rare phenomena, and we rejoice that England will now not be left behind in the friendly contest. On one of the last nights of the Session, Mr. Childers, First Lord of the Admiralty, acting, doubtless, upon information from, and in accordance with the views of the Astronomer Royal, moved in the House of Commons for a vote of £10,500, to defray the expenses of the necessary instruments and observations. He explained that the Transit of Venus in 1874 will afford an opportunity of solving one of the most interesting problems of astronomy, as it supplies the best possible means for measuring the exact distance of the Sun from the Earth; this being the unit of most other celestial measures. During the last 12 years, the astronomers of all nations have agreed as to the importance, and looked forward with the greatest interest to these observations. The Admiralty has ascertained as carefully as possible the expense that will be incurred, which is set down at £10,500, and will be spread over the next five years, so that preparations may at once be commenced, and the most perfect instruments obtained and tested. The resolution for an address to her Majesty and undertaking to defray the charge to the amount named was cordially received and carried unanimously.

SHOOTING STARS.—The French Scientific Association is preparing an expedition to observe the shooting stars in November, from various points near the coast of the Mediterranean. The principal stations are expected to be Marseilles, Nice, Perpignan, and Narbonne. A meeting of the society will be held in the first-named city about the 16th of November, to consider the result.

The Astronomical Register.—Subscriptions received by the Editor.

To December 1868.	**To September 1869.**	**To December 1869.**
Welsford. J.	Elliott, R.	Bridson, J.
To March 1870		Rump, H.R.
Coulcher, W.M.B.	**To June 1870**	Sargent, Rev. J.P.
	Welch, J.P.	Slater, Jas.

August 16, 1869.—Subscriptions received after this date in our next.

TO CORRESPONDENTS.

The Tables &c. for the month of October being given with the present number of the *Register*, No. 82 will not be published until the middle of that month.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.
The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 82. NOVEMBER. 1869.

CONTENTS.

PAGE
Spectroscopic Observations of the Sun . 209
Lunar Map and Catalogue . . 212
Inauguration of the Florence Observatory 213
Report of the "Observing Astronomical Society" 215
Correspondence:—
  Triple Stars in Draco—Mr. Proctor's Theory of the Zodiacal Light — Winnecke's Periodical Comet—Double Star Colours—Jupiter's Satellites—White Spots on the Moon—Zeta Cancri . 218–222
Brief Correspondence:—
  Minor Planets 223
  Jupiter's Satellites 223
  Solar Spots 223
The Planets for November . . 223
Astronomical Occurrences for November 224
The late Hon. Mrs. Ward . . . 226
Mr. Proctor's new Star Atlas . . 226
Hackney Scientific Association . 227
The Intra-Mercurial Planet . . 227
List of Subscribers, &c. . . . 228
Notices to Correspondents . . . 228

SPECTROSCOPIC OBSERVATIONS OF THE SUN.

Resuming our extracts from the proceedings of the Royal Society on the above important subject, we find the next communication in order of time is one from Mr. Lockyer alone, dated March 4, 1869.

Since my second paper was communicated to the Royal Society, the weather has been unfavourable to observatory work to an almost unprecedented degree; and, as a consequence, the number of observations I have been enabled to make during the last four months is very much smaller than I had hoped it would be.

Fortunately, however, the time has not been wholly lost in consequence of the weather, for, by the kindness of Dr. Frankland, I have been enabled in the interim to familiarise myself, at the Royal College of Chemistry, with the spectra of gases and vapours under previously untried conditions, and, in addition to the results already communicated to the Royal Society by Dr. Frankland and myself, the experience I have gained at the College of Chemistry has guided me greatly in my observations at the telescope.

In my former paper it was stated that a diligent search after the known third line of hydrogen in the spectrum of the chromosphere had not met with success. When, however, Dr. Frankland and myself had determined that the pressure in the chromosphere was small, and that the widening out of the hydrogen lines was due in the main, if not entirely, to pressure, I determined to seek for it again under better atmospheric conditions; and I succeeded after some failures. The position of this third line is at 2,796 of Kirchhoff's scale. It is generally excessively faint, and much more care is required to see it than is necessary in the case of the other lines; the least haze in the sky puts it out altogether.

Hence, then, with the exception of the bright yellow lines the observed spectra of the prominences and of the chromosphere correspond exactly with the spectrum of hydrogen under different conditions of pressure—a fact not only important in itself, but as pointing to what may be hoped for in the future.

With regard to the yellow line which Dr. Frankland and myself have stated may possibly be due to the radiation of a great thickness of hydrogen, it became a matter of importance to determine whether, like the red and green lines (C and F), it could be seen extending on to the limb. I have not observed this: it has always in my instrument appeared as a very fine sharp line, resting absolutely on the solar spectrum, and never encroaching on it.

Dr. Frankland and myself have pointed out that although the chromosphere and the prominences give out the spectrum of hydrogen, it does not follow that they are composed merely of that substance; supposing others to be mixed up with hydrogen, we might presume that they would be indicated by their selective absorption near the sun's limb. In this case the spectrum of the limb would contain additional Fraunhofer lines. I have pursued investigation to some extent, with at present negative results; but I find that special instrumental appliances are necessary to settle the question, and these are now being constructed.

If we assume, as already suggested by Dr. Frankland and myself, that no other extensive atmosphere besides the chromosphere overlies the photosphere, the darkening of the limb being due to the general absorption of the chromosphere, it will follow—

I. That an additional selective absorption near the limb is extremely probable.

II. That the hydrogen Fraunhofer lines indicating the absorption of the outer shell of the chromosphere will vary somewhat in thickness: this I find to be the case to a certain extent.

III. That it is not probable that the prominences will be visible on the sun's disk.

In connection with the probable chromospheric darkening of the limb, an observation of a spot on February 20th, is of importance. The spot observed was near the limb, and the absorption was much greater than anything I had seen before; so great, in fact, was the *general* absorption, that the several lines could only be distinguished with difficulty except in the very brightest region. I ascribe this to the greater length of the absorbing medium in the spot itself in the line of sight, when the spot is observed near the limb, than when it is observed in the centre of the disk: another indication of the great general absorbing power of a comparatively thin layer on rays passing through it obliquely.

I now come to the selective absorption in a spot. I have commenced a map of the spot-spectrum, which, however, will require some time to complete. In the interim I may state that the result of my work up to the present time in this direction, has been to add magnesium and barium to the material (sodium) to which I referred in my paper in 1866, No. 1 of the present series; and I no longer regard a spot simply as a cavity but as a place in which principally the vapours of sodium, barium, and magnesium (owing to a downrush) occupy a lower position than they do ordinarily in the photosphere.

I do not make this assertion merely on the strength of the lines observed to be thickest in the spot-spectrum, but also upon the following observations on the chromosphere, made on the 21st and 28th ultimo.

On both these days the brilliancy of the F line taught me that something unusual was going on, so I swept along the spectrum to see if any materials were being injected into the chromosphere.

On the 21st I caught a trace of magnesium, but it was late in the day, and I was compelled to cease observing by houses hiding the sun.

On the 28th I was more fortunate. If anything, the evidences of intense action were stronger than on the 21st, and after one glance at the F line, I turned at once to the magnesium lines. I saw them appearing short and faint at the base of the chromosphere. My work on the spots led me to imagine that I should find sodium vapour associated with the magnesium, and on turning from *b* to D I found this to be the case. I afterwards reversed barium in the same way. The spectrum of the chromosphere seemed to be full of lines, and I do not think the three substances I have named accounted for all of them. The observation was one of excessive delicacy, as the lines were short and *very thin*. The prominence was a small one, about twice the usual height of the chromosphere, but the hydrogen lines towered high above those due to the newly-injected materials. The lines of magnesium extended perhaps one-sixth of the height of the F line, barium a little less, and sodium least of all.

We have, then, the following facts:—

I. The lines of sodium, magnesium, and barium, when observed in a spot, are thicker than their usual Fraunhofer lines.

II. The lines of sodium, magnesium, and barium, when observed in the chromosphere, are thinner than their usual Fraunhofer lines.

A series of experiments bearing upon these observations is now in progress at the College of Chemistry, and will form the subject of a communication from Dr. Frankland and myself. I may at once, however, remark that we have here additional evidence of a fact I asserted in 1865 on telescopic evidence—the fact, namely, that a spot is the seat of a downrush, a downrush to a region, as we now know, where the selective absorption of the upper strata is different from what it would be (and indeed is elsewhere) at a higher level.

Messrs. De La Rue, Stewart, and Loewy, who brought forward the theory of a downrush about the same time as my observations were made in 1865, at once suggested, as one advantage of this explanation, that all the gradations of darkness, from the faculæ to the central umbra, are thus supposed to be due to the same cause—namely, the presence of a greater or less extent of a relative cooler absorbing atmosphere. This, I think, is spectroscopically established; we have, in fact, two causes for the darkening of a spot:—

I. The general absorption of the chromosphere thicker here than elsewhere, as the spot is a cavity.

II. The greater selective absorption of the lower sodium, barium, magnesium stratum, the surface of its last layer being below the ordinary level.

Messrs. De La Rue, Stewart, and Loewy also suggested in their "Researches on Solar Physics" that if the photosphere of the sun be the plane of condensation of gaseous matter, the plane may be found to be subject to periodical elevations and depressions, and that at the epoch of minimum sun-spot-frequency the plane might be uplifted very high in the solar atmosphere, so that there was comparatively little cold-absorbing atmosphere above it, and therefore great difficulty in forming a spot.

This suggestion is one of great value, and, as I pointed out in my previous paper, its accuracy can fortunately now be tested. It may happen, however, that in similar periodical fluctuations the chromosphere may be carried up and down with the photosphere, and I have already evidence that possibly such a state of things may have occurred since 1860, for I do not find the C and F Fraunhofer lines of the same relative thickness as they were in that year.* I am waiting to make observations with the large Steinheil spectroscope, before I consider this question settled. But the well-known great thickness of the F line in Sirius and other stars will point out the excessive importance of such observations as a method of ascertaining not only the physical constitution but the actual pressure of the outer limits of stellar atmospheres, and of the same atmosphere at different epochs. And when other spectra have been studied, as we have now studied hydrogen, additional means of continuing similar researches will be at our command; indeed, a somewhat careful examination of the spectra of the different classes of stars, as defined by Father Secchi, leads me to believe that several broad conclusions are not far to seek, and I hope soon to lay them before the Royal Society.

---

* I have learnt, after handing this Paper in to the Royal Society, that in Angström's Map the C and F lines are nearly of the same breadth: this I had gathered from observations made with my own spectroscope.

For some time past I have been engaged in endeavouring to obtain a sight of the prominences by using a very rapidly oscillating slit; but although I believe this method will eventually succeed, the spectroscope I employ does not allow me to apply it under sufficiently good conditions, and I am not at present satisfied with the results I have obtained.

Hearing, however, from Mr. De La Rue, on February 27, that Mr. Huggins had succeeded in anticipating me by using absorbing media and a wide slit (the description forwarded to me is short and vague), it immediately struck me, as possibly it has struck Mr. Huggins, that the wide slit is quite sufficient without any absorptive media; and during the last few days I have been perfectly enchanted with the sight which my spectroscope has revealed to me. The solar and atmospheric spectra being hidden, and the image of the wide slit alone being visible, the telescope or slit is moved slowly and the strange shadow-forms flit past. Here one is reminded by the fleecy, infinitely delicate cloud-films, of an English hedgerow with luxurious elms; here of a densely intertwined tropical forest, the intimately interwoven branches threading in all directions, the prominences generally expanding as they mount upwards and changing slowly, indeed almost imperceptibly. By this method the smallest details of the prominences and of the chromosphere itself are rendered perfectly visible and easy of observation.

On March 17, Mr. Lockyer, in an addendum to this Paper, gave some further details of the shape of the prominences as seen by his method, and some further deductions from his observations and experiments, which we defer until next number.

LUNAR MAP AND CATALOGUE.—The lunar map, commenced in 1866, under the auspices of the British Association for the Advancement of Science, and assisted by its funds, will for the future be carried on by subscription. Mr. Birt, who originated the plan and devised the mode of registration which has been adopted, will superintend the further construction of the map and the compilation of the catalogue. He also proposes to furnish subscribers with monograms of the most interesting portions of the moon's surface on a smaller scale, and has issued in this form the *Mare Serenitatis*, which is undergoing a careful revision, the number originally printed being exhausted. The subscription list contains the names of several gentlemen eminent in science; and an effort which is calculated to introduce much greater precision into observations of the moon's surface should meet with all the encouragement it deserves.—*Exeter and Plymouth Gazette*, Aug. 25, 1869.

Inauguration of the New Provisional Observatory at Florence, at Villa Galletti, on the Hill of Arcetri, between Poggio Imperiale and the Torre del Gallo. (Condensed from ' L'ITALIE *' of Sept. 27).*

This took place September 26, 1869, in presence of about two hundred distinguished public officers, and literary and scientific men, who were received by Professor Donati at the *Specola* (Observatory), which consists of a revolving room raised on a circular enclosure, the floor of which is below the level of the surrounding ground. In the middle is installed, on a stand of cast iron, the telescope made by the late Professor Amici. The revolving chamber is the work of M. G. Stoppa, mechanician; the apparatus of rotation was furnished by the foundry of Pignone, under the direction of M. Benini, and can be moved by a single person.

Professor Donati read an appropriate discourse in Italian, which, printed in double columns, Italian and French, was distributed to the guests, amongst whom were astronomers from different parts of Europe, come to Florence to confer about the measurement of a *European degree.*

The following is a translation of the professor's address:—

"Nature," said the Professor, "is dumb; she makes no answer now, unless interrogated by means of the most exquisite and perfect apparatus, such as only modern art has been able to devise and to execute. For such reasons, illustrious colleagues, you have been invited to ascend this lovely Hill of Arcetri, where thought cannot but turn to the remembrance of that great Galileo, who opened the first paths between the heavens and the earth, and whose memory is of the most glorious, not only for Florence and for Italy, but for the human race in general." After alluding to the blindness of Galileo, which happened on that spot above two centuries ago, Professor Donati said, "The wall you see, upon which this astronomical cupola rests, will be an integral part, and as it were the corner stone of a new observatory to be erected not far from this, on the highest part of the hill. Within this same circular area, where is provisionally located the great telescope, skilfully worked by my illustrious predecessor, Professor Amici, will be finally placed the apparatus which, by means of photography, registers the variations of terrestial magnetism. It is on this account that the entrance into the cupola is by a descent instead of an ascent, that the magnetic instruments, rather below the level of the ground, may be less exposed to variations of temperature. In the drawings suspended on the wall you may see the whole projection of the new observatory, made by the excellent engineer, Falcini. The external part of the building has a rectangular plane, which from east to west is 50 metres in length, and from south to north 12 metres broad. On the ground floor are some halls for study and dwelling-rooms, and there is a vast and fine hall for meridional observations, and one also for observations in the prime vertical. On the upper floor are spacious terraces, and two small moveable cupolas, one on the east and the other on the west, at the extremities of the building; and in the middle rises majestically the great cupola of the observatory. The two small lateral cupolas will be the same that are now at the observatory in Florence. The great central cupola will be that beneath which we are now assembled, the whole of which can be dismounted, and easily transported from one place to another. The whole structure is of a plain style of architecture, yet also elegant and chaste, as becomes a public edifice consecrated to the cultivation of science."

Alluding to the hindrances which so long retarded this work, the Professor remarked, "To-day a very short time sufficed you to ascend this hill, whereas I have been five long years in reaching *this first station*. The municipality of Florence was the first to come generously to the aid of science, assigning 30,000 lire for the new observatory; the noble example was followed almost immediately by our provincial council granting an equal sum; afterwards the Royal Government succeeded in assigning in 1868 28,000 lire, and H. M. the King bestowed from his private purse the sum of 15,000 lire; and the law for the total expense was finally passed by the Chamber of Deputies on May 15 of this year. You see, then, that assistance has not been wanting, and that in this case the maxim has been well understood, that as private means are insufficient for continuous scientific researches, and it being indisputable that every advancement of science, whatever it may be, becomes sooner or later of the greatest benefit to all classes, it is therefore natural and just that the public coffers and those of the wealthy should unite to enrich the patrimony of science, which is the patrimony of all." The Professor considered that day as the beginning of the history of the new Florentine observatory. He earnestly desired the progress of the sciences in general, and especially of astronomy, which more than any other has been the means of dispelling so many prejudices from the mind of man, habituating him to the inflexible immutability of the phenomena of nature, and thus contributing powerfully to shake the foundations of the edifice of falsehood and hypocrisy. He observed, "and, in fact, the phenomena of the heavens appeared to the first races as of all natural phenomena the most capricious and the most inexplicable, whence the belief that every star was the seat of an independent and supernatural power, that is to say of a God, and very soon there were formed powerful castes of persons who gave themselves to the observation of the heavens for their own mere gain, pretending that they were thus placed in direct relation with the gods; and thus the temples came to be transformed into real observatories. But, in spite of roguery, the light obtained from the heavens must sooner or later scatter the darkness of human reason; and thus observatories which in the beginning contributed so much to foment superstition, served afterwards, like the spear of Achilles, to heal humanity of the wound which themselves had inflicted, or at least made deeper. Very great has been, and is still, the influence of astronomy in the development of all the other sciences, and especially of mathematics and physics. It has frequently happened that these have made gigantic progress more through the demands made on them by the science of the stars than from their own impulse or need. Even chemistry, which was, it is true, held by the ancient alchemists to be so closely bound up with celestial phenomena that they called the metals and the planets by the same names, and which, on the overthrow of the hypocritical and false theories of the astrologers, seemed for a very long time to be the science that least of all had to do with astronomy, to-day, by virtue of so many and such stupendous discoveries, is found to be in reality so intimately associated with it, that at this very moment it is seeking to solve certain problems on the which depends the establishing of the different degrees of relationship existing between our globe and the other bodies scattered through the immensity of space; since it has been quite recently demonstrated that there is no mere poetry in the saying,

Ciò che riluce in cielo in terra fuma."[*]

In conclusion, Professor Donati expressed his hope that the new Florentine Observatory might also itself effectively contribute to the progress of science, as

Vengano i veri frutti dopo 'l fiore.[†]

General Menabrea followed with an extempore address in French, in which he mentioned that astronomy had been the favourite study of his youth, under Professor Plana, at the University of Turin. He alluded in flattering terms to the savants of all countries at that time assembled in Florence for the measurement of a new meridional arc; and his words, marked by cordiality and enthusiasm for scientific studies, were received with warm applause.

M. Parlatore, director of the Musée, then proceeded to the ceremony of inauguration.

The parchments buried contained, amongst other notices, mention of H.M. Victor Emmanuel II.—the National Treasury—and the municipality and the province of Florence, as having contributed to defray the expense. The names of MM. Angelo Bargoni, Minister of Public Instruction; L. F. Menabrea; Marquis F. Gualterio, Minister of the Royal Household; and other high public officers; and, amongst others, the following astronomers, who were present:—G. Santini, director of the Observatory at Padua; Jacob Baeyer, president of the International Commission for the Measurement of the European Degree; P. Secchi, director of the Observatory of the Roman College; C. Bruhns (Leipsic); C. Ricci, Lieut.-General, president of the Italian Commission for the Measurement of the Degree; Admiral Hirsch (Neufchâtel); Professor C. A. F. Peters (Altona); Mariano Falcini, architect of the Observatory; Professor Bouilland (de l'Institut); Professor G. Cacciatore (Palermo); Professor Schiagcavelli; A. De Gasparis; G. B. Donati; F. Parlatore, director of the Musée of Physics and Natural History.

The P. Secchi was naturally the object of attention, and deservedly so, from the merit of his conversation and his agreeable manners. He was dressed as a French (not a Roman) Jesuit—gown with small buttons, a large girdle fastened behind, no tie nor white collar, a two-cornered hat of the manufacture of Lyon, and a red rosette of an officer of the Légion d'Honneur in his button-hole. He was given always the chief places, along with the Ministers MM. Menabrea, Bargoni, and Gualterio.

At the conclusion of the ceremony Professor Donati invited the company to assemble outside the rotunda, in order that a photographer might take them in groups, which was done twice.

---

[*] That which shines in the heavens, in the earth smokes.

[†] The true fruits come after the flower.

The proceedings were terminated by a repast provided in Villa Galletti, enlivened by the band of the 43rd Regiment of the Line. The ceremony lasted from ten A.M. till half-past one P.M., and the courtesy of M. the director and MM. the professors of the Musée, with the admirable arrangement of the whole, gave satisfaction to everybody.

THE OBSERVING ASTRONOMICAL SOCIETY.

REPORT OF OBSERVATIONS MADE FROM JULY 6 to SEPTEMBER 6, 1869.

The August Meteors.

Sir,—I have received long and interesting reports from Mr. T. W. Backhouse, of Sunderland; the Rev. Ralph Prowde, of Northallerton; and Mr. H. Ormesher, of Manchester, and the following are the results obtained, inclusive of my own observations:—

Number of Meteors visible.—The following numbers refer to the sphere of vision of one observer only.

Observed by Mr. T. W. Backhouse:—

	Date.	Time.	Duration of Watch Minutes.	Number seen.
	August 9	9.42 to 9.54	12	1
	"	10.5 to 11.17	40	14
	"	12.59 to 14.8	43	20
	"	14.11 to 14.42	13	2
	10	10.5 to 11.0	31	17
	11	9.59 to 12.0	71	34
	"	13.6 to 14.17	42	18
	12	9.56 to 11.30	57	21
By the Rev. Ralph Prowde:—	11	9.30 to 12.4	—	29
	12	10.35 to 10.52	—	6
By Mr. H. Ormesher:—	9	9.0 to 13.0	—	14
	10	10.30 to 13.0	—	8
By Mr. Wm. F. Denning:—	6	10.50 to 11.50	—	10
	9	10.30 to 12.0	—	24
	10	12.10 to 12.20	—	3
	11	9.45 to 10.0	—	6
	"	10.25 to 12.0	—	55
	"	14.0 to 14.30	—	71

It is difficult to account for the discrepancies in the numbers seen by the various observers. Meteors were, perhaps, rather more frequent in some portions of the heavens than in others, or it may be that the place of observation of one observer was more favourable than that of another.

Size and Colour.—Observers agree in stating that the meteors generally were very small. There were, however, several large ones observed, and the following are the times at which they appeared:—August 9, 10.29. 10.48, 12.30.; Aug. 10, 10.46: Aug. 11, 10.58, 14.8, 14.12; Aug. 12, 10.50. With regard to the colours of the meteors it may be said that, while many of those which came under observation were either of a bluish or reddish hue, the majority appeared to be perfectly white.

Situation of the Radiant Point.—Observers do not agree in their estimates of the exact places from which the meteors emanated. The Rev. Ralph Prowde says:—"The great majority radiated from β Camelopardi." Those seen by Mr. T. W. Backhouse "were nearly all conformable to a radiant in Perseus or Cassiopeia," while Mr. H. Ormesher states, "I noticed particularly the paths of the meteors in order to determine the situation of the radiant point, and as near as I can think it would be between α and β Persei." Most of the meteors which came under my observation diverged from or near the star η Persei.

Duration of the Trains.—Nearly all the larger meteors were accompanied with trains, which in several cases remained visible four or five seconds after the meteor itself had disappeared. The train left by a brilliant meteor at 14.8 on August 11 appears to have been perceptible to the naked eye much longer than any other. It at first presented the appearance of a brilliant streak of light, about 15 degrees in length, which immediately began to contract, assuming a wavy or serpentine form. Nearly two minutes after the disappearance of the meteor this train was faintly perceptible as an ill-defined, nebulous patch, which had drifted about three degrees from the position it had first occupied.

Remarks.—It appears probable that meteors were most numerous on the 10th; but owing to cloud, observations could not be satisfactorily made. With regard to the precise points of divergence of the meteors, it would appear that the majority fell from β Camelopardi and η Persei—two points of radiation previously determined by observers of meteoric showers.

The recent display is remarkable for the numerous small meteors visible, and the consequent absence (with but few exceptions) of any of the larger class.

Winnecke's Periodical Comet.

Mr. Charles Hill, of Bristol, observed this object with his 8½-inch silvered glass reflector, during the night of the 3rd of September, when the atmosphere was very favourable. He says:—"My impression was that the comet is not so well defined and more elongated than it appeared before its perihelion passage. Now and then I could just perceive something of a nucleus, or possibly a faint star, in the line of sight.

Lunar Observations.

Amongst other objects, the crater Plato has received attention. Webb (Cel. Obj. p. 97), in speaking of its interior, says it contains several little craters, which may be classed among the minutest of lunar objects.

Mr. John Birmingham, of Tuam, on examining this object near the morning terminator, succeeded in detecting four small spots on the floor of the crater; but, owing to bad definition, he "could not say whether they were hillocks or craters." On viewing it at the evening terminator, he saw "a small crater on a spur of the rampart, where, apparently, a large half-obsolete crater once abutted on Plato." He also made several sketches of the forms of the shadow of the wall surrounding the crater. These, together with other lunar observations by Mr. James Cook, of Preston, and Mr. H. Michell Whitley, of Penarth, Truro, have been forwarded to Mr. W. R. Birt.

The Planet Jupiter.

Mr. H. Ormesher, of Manchester, witnessed the partial transit of the 3rd satellite on the night of the 14th of August. The satellite was visible as a bright spot 15 minutes after first contact. On the night of the 24th of August the 2nd satellite was observed during its ingress. Mr. Ormesher says, "After first contact the satellite appeared to linger for some time." A somewhat analagous phenomenon is noticed at p. 141 of Webb's "Celestial Objects."

Occultation.

On the evening of the 27th of August, the fourth magnitude star, Mu Ceti, should have been (according to the Nautical Almanac) occulted by the moon for 32 minutes. Mr. H. Ormesher, however, watched the star approach very near the moon at the given time, but it escaped occultation.

I am, Sir, truly yours,
Ashley Road, Bristol. WILLIAM F. DENNING, *Hon. Sec.*

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

TRIPLE STARS IN DRACO.

Sir,—In sweeping with my reflector through the constellation Draco, I have frequently met with a delicate triple star about two-thirds of a degree to the north-west of Herschel's planetary nebula 37 ♅ iv. Its approximate position in R. A. being 17h. 52m. and due north 66° 58′.

The stars are in a straight line; *a* and *b* are each distant about 13″ from *c*. I estimate the magnitudes *a* 8·9; *b*, 9·0; and *c*, 11·8. The colours respectively look like (*a*) pale red, (*b*) faint blue, and (*c*) faint lilac. So far as I can ascertain this object is not to be met with in Struve's large Catalogue, where it seems most likely to be recorded, which is the more remarkable as several objects in the locality are given.

No one could possibly come across such an object without pronouncing it a fine triple star. The symmetry in position, distance, and magnitude, eminently entitle it to this appellation. I find the small central star, *c*, is almost extinguished with a five-inch aperture, to which it seems a *minimum visibile*. To those who have sufficient telescopic power I can recommend this object as well worthy of examination.

Yours faithfully,
Birmingham, August 25, 1869. F. BIRD.

MR. PROCTOR'S THEORY OF THE ZODIACAL LIGHT.

Sir,—Until I read Mr. Elvin's letter in your August number, I was not aware I had formed a theory about the zodiacal light. As I have, I must claim full right and title to it; for it has not been borrowed from Mr. Elvin's nor from anyone. Will some one kindly tell me what it is?

I learn with interest, too, that I have expressed very definite views about the relations between meteors and comets. I hope these views of mine are well founded, and I could have wished that Mr. Elvin had told me *why* I hold them, because they seem rather bold.

I like Mr. Elvin's explanation of cometic phenomena by a simple reference to the laws of motion. There are only two points about it which seem to require modification. At present it is inconsistent with the laws

ON THE SIGNS OF THE ZODIAC,

WITH THEIR

STARS AND CHIEF CONSTELLATIONS,

IN THEIR SEASONS.

Westward whene'er the Plough you see,
Cassiopeia east will be;
Vega will shine in southern sky;
Capella sparkle north on high;
Their places only, as they range,
From time to time we find them change;
They never set, still shining here,
Star-guides for this our hemisphere.
Fantastic forms by men were giv'n,
To track through them the maze of heaven.

♈ When the sun's course is in the sky,
(Aries.) Through the Ram's stars that shine on high,
'Tis then his light and warmth doth bring
The genial season of the spring.
Now Arietis red, is seen,
In the Ram's head, the horns between;
Above his head, the stars that spangle
Give shape and name to the Triangle.
Menkar now view in Cetus' head—
'Neath the Ram's feet a monster spread.
Lower is Mira's changeful light,
Now dimly seen, now shining bright.
Northward, is Cassiopeia's chair,
Seated thereon the fabled fair;
A constellation mark'd and high,
Resembling **W** ($^{*}{}_{*}{}^{*}{}_{*}{}^{*}$) in the sky.
Below her, Perseus, hero bold,
Medusa's head has firm in hold;
Its chief star, Algol, changeful beam,
Casts from the head a lurid gleam.

♉ Under Perseus, in the Bull,
(Taurus.) Glows Aldebaran, red and full.
In Pleiades, a cluster, see
The star we call Alcyone;
By scientific men 'tis found
A central point: that star around,

Guided by power Divine, and love,
Our sun, and all the planets move.
Near the Bull's mouth, faint in lustre,
See Hyades, assembled cluster.
Straight from Capella's golden beams,
Light chasing darkness swiftly streams,
This lovely star so bright doth roll
For ever round the Northern Pole.
Beneath her comes with speedy stride—
His sword seen pendant at his side—
Orion, girded as for war,
Betelgueze red, his chiefest star ;
Rigel, Bellatrix, both most bright,
Rob'd we view in aureate light.
Unto Orion, as here giv'n,
The Pole-star points from highest heaven,
And bright Capella's star is seen
Shining about mid-way between.

♊ (Gemini.) The TWINS* we near Auriga view,
Two stars of a pale orange hue,
With feet upon the Milky Way,
Their mutual love they each display.
Orion's right, nearest of all
The stars above our earthly ball
Is Sirius—he, the Prince of Night,
Has burst, though daylight, into sight.
Above, too, Procyon seems to vie,
Radiant orb in azure sky.

♋ (Cancer.) The CRAB marks summer. The Great Bear
Contains the Plough, see it appear,
But never set ; it was, of old,
Call'd by the Arabs "The Great Fold."
Dubhe and Mirach pointers are,
To sailors guide the Polar star.
What Eastern sage, of earliest fame,
Gave to chief stars their proper name?
Before Greece rose, their names were given
To all the brightest stars in heaven—
Divine instructive names—each light
That pours its beauty into night.†

---

* Castor and Pollux.

† "Mazzaroth ; or, The Constellations"—Rivington. "Names and Emblems of the Signs of the Zodiac"—Macintosh.

♌ (Leo.)
The LION comes, as if to tread
Upon the Hydra's hateful head.
Now Regulus, with diamond sheen—
And Deneb near the Virgin seen,
Two Lion's stars, the first more bright,
Have cast their beams into the night.
If these stars you should wish to trace,
Finding for each its proper place,
Then draw a line from Polar star,
Straight through the pointers of the Bear,
Till it come to the Lion's sign,
Where these two stars so brightly shine.

♍ (Virgo.)
The VIRGIN leads the Jewish year;
South-east in sky she doth appear.
Spica, Vindemiatrix shine,
In northern and in southern clime.
Boötes stars the Crown are near;
Arcturus is both red and clear.

♎ (Libra.)
The starry SCALES in heaven that shine,
Of justice are the type Divine.
Now when the autumn sky is clear,
The stars more brilliant appear.
Al Phecca is the Crown's bright gem.
Worthy of such a diadem.

♏ (Scorpio.)
In the SCORPION'S sign, a star,
Antares, red, gleams from afar.
Just between Lyra and the Crown.
The stars of Hercules look down;
More like a lily these would seem,
Near to the Northern Crown's bright gleam.
Not far hence Ophiuchus stands,
Grasping the Serpent in his hands,
Whilst with his foot he seems to tread
Right upon the Scorpion's head.

♐ (Sagittarius.)
The battle-bow the ARCHER bears;
The Scorpion in front appears.
Bright Vega to the Lyre belongs,
Foretoken of triumphant songs;
A star that never sets—'tis found
Circling the Pole star ever round.

Etanin in the Dragon's head,
Half round the Pole this serpent's spread.

♑ The SEA GOAT marks the Winter time,
(Capricornus.) When in this Sign the sun doth shine.
Three of the Eagle's stars so bright,
Point straight to Vega's lamp of night;
Near also to the Little Bear,
The chiefest of them is Altair.

♒ From AQUARIUS' urn doth flow
(Aquarius,) Water on fish called Fom al haut;
Water thus, as poured from heaven,
Is a type of blessing given.
Of justice, too, the flood—the wrath
Upon a guilty world pour'd forth,
Egypt's great Pyramid doth stand
Pledge in that monumental land.*
Next comes swift Pegasus, winged horse,
With Markab, Sheat in their course.
See in the Swan, so radiant bright,
Is Arided's unsetting light;
This constellation's place is seen,
The Lyre and Pegasus between.

♓ Two FISHES though far asunder,
(Pisces.) Are link'd by bands—a mystic wonder.
The fair Andromeda here see,
The fabled bride Perseus set free;
Now Alpherat, the chiefest star,
Sheds o'er her head its light afar.
Near to the Pole does Cepheus stand,
His left it is the scept'red hand;
In his right arm with light serene,
Lo, Alderamin's star is seen.
On March the twentieth the sun
In this last sign his course hath run.

I. H. BROOME (Houghton.)

---

* For proofs, see "Life and Work at the Great Pyramid," Vol. iii., pp. 488 to 495; by Professor C. Piazzi Smyth, Astronomer Royal for Scotland. "The Religions of the World," pp. 16 to 19, and p. 44; by William Osburn.

LONDON: PRINTED BY
S. GORTON, PRIVATE PRESS, PARNHAM HOUSE,
PEMBURY ROAD, CLAPTON.

of motion, and is open to the further objection of not accounting for cometic phenomena. These, however, are details. In all other respects it is admirable.

I am, Sir, yours faithfully,

August 1869. RICHARD A. PROCTOR, B.A., F.R.A.S.

WINNECKE'S PERIODICAL COMET.

Sir,—This body having long ago passed its perihelion has not however passed wholly away from us, and the following ephemeris for the month of November, calculated by M. Oppolzer, of Vienna, will doubtless interest many of your readers :—

	R.A.			Decl.	
1869.	h.	m.	s.	°	′
Nov. 1	1	34	32	12	46·4
3	1	32	24	12	32·7
5	1	30	26	12	18·1
7	1	28	40	12	2·7
9	1	27	5	12	46·7
11	1	25	40	11	30·0
13	1	24	25	11	12·8
15	1	23	20	10	55·1
17	1	22	24	10	36·9
19	1	21	37	10	18·4
21	1	20	59	9	59·5
23	1	20	29	9	40·4
25	1	20	7	9	21.0
27	1	19	53	9	1·4
29	1	19	47	8	41·5

I am, Sir, your obedient Servant,

Bickley, Kent, October 20, 1869. G. F. CHAMBERS.

P.S.—A new comet was discovered by Tempel, on October 9, in R.A. 158° 30′, Decl. 2° 10′. It is described as faint.

DOUBLE STAR COLOURS.

Sir,—Amongst the numerous objects of interest to which the amateur astronomer can direct his telescope there are none which excel in beauty the contrasted tints of the numerous double stars with which the heavens are so thickly strewn. But though charming from the varied hue of different pairs, the study of star colours gains greatly in interest when we bear in mind the fact that it is more than suspected that actual changes of colour occur in some stars. It then becomes of value to record any suspicious instances, as it is only by an accumulation of observations that we shall be able to verify any change.

I have, for the last two years, paid some attention to this subject, and have observed a number of double stars, taking Mr. Webb's admirably-written work, "Celestial Objects," as a standard of comparison; and although, in the majority of cases, the colours I have ascribed to the stars correspond with those given by him, or agree so nearly in tint that the difference may be ascribed to "Personal Chromatic Equation," yet there are several instances in which this reason appears to me hardly sufficient, and I have placed the most striking of these in the following table.

The colours given by Mr. Webb are those of the Bedford catalogue, and

I have added to the list some notes (for which I am mainly indebted to Mr. Webb's papers), giving the results obtained by different astronomers.

The observations were made with an achromatic, by Dollond, of $3\frac{3}{4}''$ aperture; negative eye-pieces, with powers varying between 60 and 300, being alone used.

Star	Webb	Epoch	Whitley	Epoch
56 Andromedæ	Both yellow	1834	Yellow, orange	1869·4
12 P xx Antinoi	Both pale grey	. .	White, grey	1868·7
57 Aquilæ	Both blue	1834	Bright white, reddish white	1868·7
λ Arietis	Yellowish white, blue	. .	Pale yellow, reddish lilac	1868·7
30 Arietis	Topaz yellow, pale grey	. .	Both grey	1868·7
δ Boötis	Pale yellow, light blue	. .	Yellowish white, dusky	1869·3
μ Boötis	Flushed white, greenish white	. .	White, lilac	1869·3
ϕ_2 Cancri	Both silvery white	. .	Both silvery white	1868·9
12 Canum	Flushed white, pale lilac	1837	White, grey	1869·3
101.100 Pxx Cassiopeæ	Light yellow, white	1830	Pale yellow, light blue	1868·7
Y Coronæ	Bluish white, smalt blue	. .	Bluish white, dull white	1868·8
δ Corvi	Pale yellow, purple	. .	White, grey	1869·4
γ Delphin	Yellow, light emerald	. .	Both yellowish white	1867·9
ρ Herculis	Bluish white, pale emerald	. .	Both white	1868·7
γ Leporis	Light yellow, pale green	1832	White, light red	1868·1
η Lyræ	Sky blue, violet	1834	White, grey	1869·4
8 Monocerotis	Golden yellow, lilac	. .	White, grey	1868·1 1868·9
20 Geminorum	Topaz yellow, cerulean blue	. .	Both white	1868·9
λ Orionis	Pale white, violet	1833	White, ruddy	1868·9
α Piscium	Pale green, blue	1830	Bluish white, reddish white	1867·9

NOTES.

56 Andromedæ, Struve, p. star, smaller and always deeper in colour. Webb, p. larger and ruddier, 1850. I found p. smaller and ruddier, 1867–9. Do these stars vary?

12 P xx Antinoi, Webb, yellowish bluish, 1850.

57 Aquilæ, Webb, pale yellow, pale lilac, 1855.

ϕ^2 Cancri, Dembowski, both yellow, 1854.

12 Canum (Cor Caroli), Struve, both white, 1830; Sestini, yellow, blue, 1844, 5; Smyth, full white, very pale, 1850–5; Ditto, pale reddish white, lilac, 1855; Dembowski, white, pale olive blue, 1856; Knott, very pale yellow, almost white, pale lilac, 1855.4; Webb, pale yellow fawn, 1865.4. I made them white, pale purple, 1868.2, white, grey, 1869.3.

δ Corvi, Sestini calls the small star white.

γ Delphini, golden yellow, flushed grey, 1850–7.

ρ Herculis, Dembowski, four reddish white, 1853–5.

γ Leporis, Webb, pale yellow, garnet, 1851.

η Lyra, Webb, yellow, greenish or bluish, 1849,50.

λ Orionis, Dembowski, yellow, blue, 1856.

α Piscium, Struve, pale green, blue, 1831; Fletcher, both yellow, 1851; Dembowski, white, ashy white, 1854.

Must we assume that the changes of colour shown above are all due to "Personal Equation?" It appears to me that in many instances, especially in that of Cor Caroli, they pass beyond its limits, and point to an actual change of colour having taken place in the light emitted by the star itself.

Penarth, Truro: Sept. 15, 1869. H. MICHELL WHITLEY.

JUPITER'S SATELLITES.

Sir,—Allow me to make a remark on three observations of the first satellite of Jupiter, accurately taken on the 21st and 22nd inst., with a Newton's 5-feet telescope, an aperture of 4½ and power 110.

1. The eclipse of this satellite is announced in the N. A. Greenwich time, Sept. 21, to take place at 8h. 56m. 44·2s.: by observation it disappeared at 10h. 53m. 0s., the difference in time being 1h. 56m. 15·8s., which is the true difference of time between this meridian and that of Greenwich.

2. The transit immersion of the same satellite is given in the N. A., on the 23rd inst., 7h. 20m. This took place from my point of view at 9h. 15m. 30s., the difference being 1h. 55m. 30s.

3. The transit emersion of the same satellite is by the N. A. 9h. 30m. I traced the satellite across the disc, and saw it emerge at 11h. 23m. 30s., the difference being 1h. 53m. 30s. The emergence was therefore 2m. earlier than the time announced in the N. A.

These observations were made under favourable circumstances, the sky being perfectly clear, and the atmosphere calm.

I am, &c.,
CHAS. B. GRIBBLE, M.A., F.R.A.S.,
Pera: Sept. 22, 1869. *Chaplain to H.M. Embassy.*

Sir,—On turning my telescope (a 6-feet equatorial, by Cooke) to the planet Jupiter, on the night of Saturday last, the 21st inst., at about 12h. 15m. G.M.T., I observed what to me was an entirely novel appearance. It was the shadow of the third satellite transiting the disc, not at all within the usual distance of the planet's equator, but within a very short distance of its southern pole. I found that an amateur friend of mine had noticed the same phenomenon, and we should both be indebted to any of your better informed readers if they would kindly explain the cause of this certainly monstrous appearance.

I remain, Sir, your constant reader and subscriber,
Mortimer Vicarage, Reading: R. T. GOULD.
Aug. 24, 1869.

WHITE SPOTS ON THE MOON.

Sir,—In the number of the *Register* for October 1867, will be found an interesting paper by Herr Tempel, translated by W. T. Lynn, Esq., on the round white spots so frequently seen on various parts of the moon, especially about the time of "full," which are referred by the author to a "chemically warm activity." We however require the *proof* of this activity. Mr. Pratt, of Brighton, and Mr. Gledhill, the assistant of E. Crossley, Esq., of Halifax, having sent me series of observations of the spots on *Plato*, between February 23 and September 27, 1869, numbering with a few others 238 observations, I have been able to deduce an approximate scale of the degree of visibility of 16 of the 26 spots, records of which are in existence as follows:—

No.	1.	4.	3.	14.	17.	5.	13.	19.
Visibility ...	1·000	·844	·782	·656	·656	·625	·531	·531
No.	16.	22.	6.	7.	10.	9.	12.	20.
Visibility ...	·406	·281	·250	·250	·187	·156	·094	·094

This scale of visibility is likely to assist in throwing some light on the suggestion of Herr Tempel, for if the activity of which he speaks be *intermittent*, and the spot is visible only while it is in progress, should it take place *frequently* the degree of visibility will *rise*, but if only *occasionally* it will *fall*. As the number of observations for comparison should be about the same, it is manifest that the greater the number of observers the shorter will be the interval, and the oftener the comparisons could be made, and we should thus have the means of ascertaining if "activity" were still in existence; for the surface of the moon being in a state of fixity, and the earth's atmosphere remaining subject to the same variations as now, variation in the degree of visibility ought not to obtain.

I am, Sir, yours truly,
W. R. BIRT.

Cynthia Villa, Walthamstow,
October 19, 1869.

ZETA CANCRI.

Sir,—I have some hesitation in attempting to reply to an observer of so much more experience than myself as the Rev. H. C. Key (p. 171), who has done me the honour to refer to communications sent you previously on this star. I am afraid I shall not lessen the difficulty of reconciling them with his observations. Any attempt at corroboration, in the face of the circumstances mentioned by Mr. Key, will probably appear futile; but I venture to mention that in March, 1868, my friend Mr. H. Jackson, who was with me, saw the stars separated, and gave me his independent estimate of their position, which agreed with mine. Perhaps a *comparison* is not quite without value: 1868, Dec. 23, I found OΣ 175 near Castor (0″·5) *closer* than ζ Cancri; 1869, Feb. 18, I found with 6½in. ap., power 320, that the latter was *more easily notched* than the former.

I have recently projected the measures quoted by Mr. Key, and if he will kindly do the same, adding the following (including his own two estimates), probably he will conclude with me, that if all of them are correct, the apparent orbit of Cancri is a very curious one.

		°	″
Secchi . . .	1857·28 ...	303·9 ...	0·77
Knott . . .	1866·26 ...	233·6 ...	0·78
Secchi . . .	1866·28 ...	234·6 ...	0·40
Knott . . .	1866·94 ...	228·3 ...	0·66
Key . . .	1868·35 ...	229 ...	0·20
,, . . .	1869·33 ...	192 ...	[0·30?]

Until further *measures* are published, a distance of 0″·6 at the two epochs of my observations seems more likely to fall near the ellipse. The estimated *positions* (made at the telescope) are of course only approximations.

		°	″
Buffham . . .	1868·22 ...	223 ...	0·6
,, . . .	1868·97 ...	220 ...	0·6

The position of A C was assumed to be 140°.

Perhaps Mr. Darby could contribute something towards the question.

I am, Sir, yours truly,
T. H. BUFFHAM.

Earith, Hunts: Sept. 3, 1869.

BRIEF CORRESPONDENCE.

Minor Planets.—Will you kindly inform me, at your leisure, whether there are any asteroids at present within the signs Aries, Taurus, and Gemini, or in their immediate neighbourhood, suitable for a 3-inch refractor, powers from 50 to 150? I have not a nautical almanac, or any means in this country curacy of ascertaining the above information. If there should, therefore, be one or more minor planets in that quarter of the heavens, might I ask the favour of their positions for any night this month, or your recommendation of any other source of obtaining their positions.

W. T. Holden.

Jupiter's Satellites.—I had, a few nights since, a very satisfactory view ot Jupiter's third satellite, by the unassisted eye; and afterwards, on viewing it with a good binocular opera-glass, not only verified having seen it without its aid, but observed that the difference was only such as the additional optical power might be expected to give; and on referring to the N. A., which I had purposely refrained from doing before, found the position laid down to agree with that observed, so that, notwithstanding your correspondent "C.'s" scepticism, I must still believe my eyes.

W. L. B.

Solar Spots.—In reply to J. Birmingham's remark in your last number, p. 170, the black spot within the nuclei of many solar spots is mentioned in Webb's "Celestial Objects for Common Telescopes," first edition, p. 21; and in most large spots there is great irregularity in shade in the nucleus.

T. W. B.

THE PLANETS FOR NOVEMBER.

At Transit over the Meridian of Greenwich.

Planets	Date	Right Ascension	Declination	Diameter	Meridian Passage
		h m s	° ′		h m
Mercury	5th	13 37 18	− 7 43	6″·6	22 34·6
	20th	14 58 57	15 48½	5″·1	22 57·0
Venus	5th	17 47 0	−25 59	17″·4	2 47·5
	20th	19 2 58	25 29	19″·7	3 4·3
Jupiter	5th	2 56 38	+15 27	46″·2	11 55·7
	20th	2 48 40	14 54	45″·8	10 48·7
Neptune	5th	1 7 6	+ 5 17½	—	10 6·5
	20th	1 5 52	5 10½	—	9 6·2

ASTRONOMICAL OCCURRENCES FOR NOV. 1869.

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Mon	1		Sidereal Time at Mean Noon, 14 43 14·4	3rd Sh. E. „ Tr. E. 2nd Ec. D.	4 55 5 22 16 34 55	Jupiter — 12 13·5
Tues	2	2 17	Conjunction of Moon and Mercury, 3° 1′ S. Meridian passage of the Sun, 16m. 19s. before Mean Noon			12 9·1
Wed	3	11 35	● New Moon	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E. 1st Sh. I. „ Tr. I.	10 47 11 3 13 8 13 18 17 41 17 48	12 4·6
Thur	4	16 29	Greatest westerly elongation of Mercury, 18° 48′	1st Ec. D. 3rd Ec. D. 1st Oc. R. 3rd Oc. R.	14 52 13 16 49 27 17 6 18 50	12 0·1
Fri	5	14 48 18 43	Conjunction of Moon and Mars, 4° 40′ S. Conjunction of Moon and Saturn, 2° 22′ S.	2nd Ec. D. „ Oc. R. 1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	5 52 38 8 16 12 10 12 14 14 22 14 25	11 55·7
Sat	6	18 5	Conjunction of Moon and Venus, 5° 20′ S.	1st Ec. D. „ Oc. R.	9 20 54 11 32	11 51·2
Sun	7	18 20	Saturn's Ring: Major Axis=34″·46 Minor Axis=15″·58 Opposition of Jupiter	1st Sh. I. „ Tr. I. „ Tr. E. „ Sh. E.	6 38 6 40 8 50 8 50	11 46·7
Mon	8	4 22 5 36 7 20 7 59	Occultation of 50 Sagitarii (6) Reappearance of ditto Occultation of B.A.C., 6671 (6) Reappearance of ditto	1st Oc. R. 3rd Sh. I. „ Tr. I. „ Tr. E. „ Sh. E.	5 58 6 52 7 2 8 38 8 56	Moon — 4 5·5
Tues	9	2 37	Conjunction of Saturn and Mars, 2° 10′ S.			4 58·3
Wed	10	7 11 7 49 14 56	Occultation of 30 Capricorni (6) Reappearance of ditto ☽ Moon's First Quarter	2nd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	13 18 13 24 15 33 15 45	5 48·1
Thur	11			1st Oc. D.	16 39	6 35·0
Fri	12			2nd Oc. D. „ Ec. R. 1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	8 14 10 43 38 13 57 14 4 16 8 16 16	7 19·5
Sat	13			1st Oc. D. „ Ec. R.	11 5 13 23 33	8 2.1
Sun	14			2nd Tr. E. „ Sh. E. 1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	4 41 5 4 8 23 8 33 10 34 10 45	8 43·7
Mon	15		Illuminated portion of disk of Venus=0·628 of Mars=0·975	„ Oc. D. „ Ec. R. 3rd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	5 31 7 52 24 10 16 10 54 11 56 12 57	9 25·1
es	*16*		Sidereal Time at Mean Noon, 15 14 22·8	1st Tr. E. „ Sh. E.	5 0 5 14	Moon 10 7

DATE		Principal Occurrences		Jupiter's Satellites		Meridian Passage
		h. m.			h. m. s.	h. m.
Wed	17	9 49 11 0 16 50	Occultation of μ Ceti (4) Reappearance of ditto Conjunction of Moon and Jupiter, 3° 48′ N.	**2**nd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	15 33 16 2 17 49 18 23	10 50·3
Thur	18	19 18	○ Full Moon Meridian Passage of the Sun, 14m. 37s. before Mean Noon			11 35·4
Fri	19	9 44 11 0	Occultation of 63 Tauri (6) Reappearance of ditto	**2**nd Oc. D. „ Ec. R. **1**st Tr. I. „ Sh. I. „ Tr. E.	10 27 13 19 13 15 41 15 59 17 51	Jupiter — 10 53·2
Sat	20	3 14 5 47 6 33	Conjunction of Venus and ψ Sagittarii (14m·5) E. Occultation of *m* Tauri (5½) Reappearance of ditto	**1**st Oc. D. „ Ec. R.	12 49 15 18 46	10 48·7
Sun	21	1 18 6 52 7 44 20 13 20 30	Conjunction of Venus and ψ Sagittarii (0° 7′) S. Occultation of ψ^4 Orionis (5) Reappearance of ditto Occultation of ν Geminorum (4½) Reappearance of ditto	**2**nd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E. **1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	4 42 5 21 6 57 7 42 10 7 10 28 12 18 12 40	10 44·3
Mon	22	8 51 9 46 18 21 19 25	Occultation of ξ^2 Geminorum (4) Reappearance of ditto Occultation of 56 Geminorum (5½) Reappearance of ditto	**1**st Oc. D. „ Ec. R. **3**rd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	7 15 9 47 40 13 30 14 55 15 14 16 58	10 39·9
Tues	23	2 31	Conjunction of Moon and Uranus, 1° 12′ N.	**1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	4 33 4 56 6 44 7 8	10 35·4
Wed	24			**1**st Ec. R. **2**nd Tr. I.	4 16 28 17 49	10 31·0
Thur	25	19 12 19 23	Occultation of 34 Leonis (6) Reappearance of ditto			10 26·6
Fri	26	6 14	☾ Moon's Last Quarter	**3**rd Oc. R. „ Ec. D. „ Ec. R. **2**nd Oc. D. „ Ec. R. **1**st Tr. I.	4 44 4 53 27 6 40 50 12 41 15 54 49 17 25	10 22·2
Sat	27	13 37 19 9 19 35	Occultation, reappearance of B.A.C. 3996 (6) Occultation of *b* Virginis (6) Reappearance of ditto	**1**st Oc. D. „ Ec. R.	14 34 17 14 8	10 17·8
Sun	28		Saturn's ring: Major axis = 34″·10 Minor axis = 15″·44	**2**nd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E. **1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	6 58 7 59 9 15 10 20 11 51 12 22 14 2 14 34	10 13·5
Mon	29			**1**st Oc. D. „ Ec. R. **3**rd Tr. I.	9 0 11 43 4 16 47	10 9·1
Tues	30			**2**nd Ec. R. **1**st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	5 12 37 6 17 6 51 8 28 9 3	10 4·7

THE LATE HON. MRS. WARD.

AGAIN we have to record the loss of a distinguished labourer in the fields of astronomy. The Hon. Mrs. Ward—the author of *Telescope Teachings*, also of *Microscope Teachings*, and various other writings of high scientific interest—is no more, and her untimely death is made still more lamentable by the dreadful way in which it occurred. She may not wrongly be numbered among the many victims to science, by her love of which she was induced to ride on a carriage-road steam-engine when on a visit at Birr Castle, the seat of the Earl of Rosse. Unfortunately, seated on the front part of the machine, she was thrown off by some sudden movement or jolt, and fell under the wheel, which caused such injuries that death was almost instantaneous. Mrs. Ward was a true genius. Her talent for drawing was exquisite, and her power in literary composition of a high order. We just now remember how we were struck with a passage in an article from her pen in the *Intellectual Observer*, where she described the denser aggregation in our part of the November meteor zone as "the gem in the ring." In whole volumes of the current literature of the day we might vainly seek for an image equally true and poetic; and, were this the place to do it, we could easily multiply examples of style from her comparatively few writings that would show her vast superiority to many who fill the book-stalls with their productions.

But high as was the intellect of Mrs. Ward, her qualities of the heart were not less excellent; and not on the surface of this revolving globe, whose phenomena she so loved to investigate, did there exist one more estimable as a wife, a mother, and a friend.

She received her astronomical education principally from her uncle, the late Lord Rosse, by whose side in the tomb, in consideration of the great love he bore to her, she has, we believe, been laid. Her husband, the Hon. Captain H. C. Ward, is brother to Viscount Bangor, who is unmarried, and their son, still a boy of tender years, is the present heir presumptive to the title. It may not be out of place to remark that Lord Farnham, who lost his life by another awful accident—in the celebrated burning of the Irish mail train at Abergele—was uncle to Captain Ward.

MR. PROCTOR'S NEW STAR ATLAS.

We notice that Mr. Proctor, who has perhaps given more attention than any living astronomer to the construction of Star Maps, is about to bring out what will, we think, be a very useful atlas. When describing his former maps (in twelve pentagons) we ventured to observe that the scale was perhaps too minute; the present maps (whose superficial scale is more than nine times greater) will completely obviate that defect, and prove extremely useful to all observers, whether engaged with the telescope or occupied in cataloguing. With the assistance of Mr. Brothers and Mr. Baxendell, there can be no doubt that a most useful work will be the result of Mr. Proctor's labours, and we feel sure that all interested in the science will do well to enroll their names as subscribers on the form which accompanies this number of the *Register*, and send the same to Mr. Brothers, of Manchester.

HACKNEY SCIENTIFIC ASSOCIATION.—The annual conversazione of this association was held on the evening of October 19, 1869, at Luxemburg Hall, Dalston, and great credit is due to the committee of management for the very excellent intellectual entertainment provided for the occasion. A large number of microscopes gave the visitors assembled opportunities of inspecting the minute objects in the natural world. We remarked an interesting collection of geological specimens, also numerous diagrams, lines of electric telegraphs in operation, &c. The collection of apparatus exhibited by Mr. Browning was a point of great attraction, consisting of spectroscopes, induction coils, and other instruments. Astronomy was represented by a series of hemispheres and diagrams, also by several lunar photograms, including a specimen from the great Melbourne telescope—one on glass, taken by Mr. Gill, of Aberdeen, in February last, was so mounted that when viewed by a small telescope it presented a striking resemblance to the appearance of the moon as seen through an aperture of four or five inches, with a power of 100. The collection was exhibited by Mr. Birt, who explained during the evening the general physical features of the moon's surface, and pointed out, on a fine photogram by Rutherford, the evidence we possess of changes which have successively modified it. The evening was enlivened by several musical pieces, chemical experiments, and an address delivered by W. T. Lynn, Esq., one of the vice-presidents, on "The Advantages of Scientific Culture," including his special department, astronomy.

WAS IT THE INTRA-MERCURIAL PLANET?—We clip the following from the Des Moines *State Register* of the 8th inst., in regard to the search for the "pseudo-planet" Vulcan during the eclipse:—Prof. Newcomb, whose observatory was situated in the Court House Square, and whose observations were solely for the discovery of inter-mercurial planets, or planets between Mercury and the Sun, searched that region thoroughly, and found nothing that would indicate the existence of planets of that kind. The question of their existence has been a mooted one among astronomers, and as Mercury is very seldom visible, even with the aid of powerful telescopes, research has been very limited, and as this total obscuration of the sun opened the whole field for observation, Prof. Newcomb, assisted by Prof. Armstrong, availed himself of the opportunity. Since our report of the eclipse, we have had a conversation with Mr. W. S. Gilman, Junr., who occupied the station at St. Paul Junction in this county. From his note-book we are allowed to copy the following:—"A few moments subsequent to the second contact several of the party, as will appear by reference to the notes at the end of my report, noticed a small but exceedingly bright point, like a star, below the moon's disc, at the edge of the corona. Mr. Farrell notes the position in his sketch, (I,) and estimated its magnitude as about one-sixth of the size of Mercury, which planet was almost directly to the right of it, on a line parallel to the horizon. The star was independently discovered by Mr. Farrell, Mrs. Farrell, Mr. Phelps, and Mr. Locklin, both with and without instruments, and each was very positive of the reality of the appearance. The star was located independently by each observer, a little to the right of the moon's centre, and below it. The approximate position of the little brilliant, with reference to solar disc, was about 225° from the north point."—*Sioux City Daily Times.*

LIST OF SUBSCRIBERS—Names received since our last number.

Carrara, Sig. Giuseppe, Barone, Caffè S. Giu. Crisostomo, Venezia.
Ellery, R. J., Esq., Director, Melbourne Observatory.
Todé, E. H., Esq., 40 Tavistock Street, Covent Garden.
Ormersher, H., Esq., 60 Green Lane, Patricroft, Manchester.
Woodman, T. C., Esq., 31 York Road, Hove, Brighton.
Toy, E. P., Esq., Mantling Hall, Littlehampton.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor.

To February 1867.

Southern, W.

To June 1869.

Jackson, J. F.
Morton, Rev. J.

To September 1869.

Metcalf, Rev. W.
Troward, C.

To December 1869.

Blacklock, A. W.
Buffham, T. H.
Cooper, Sir H.
Cook, James.
Forward, R.
Heelis, J.
Horner, Rev. J.
Hemming, Rev. B. F.
Lancaster, J. L.
Lancaster, W.
Oldfield, W.
Parkes, Rev. J.
Ryley, F. B.
Reside, J.
Todé, E. H.
Toy, E. P.
Williams, J. M.
Woodman, T. C.
Wright, W. H.

To March 1870.

Banks, W. L.
Herschel, A. S.
Mills, E. B.

To June 1870.

Green, Joseph.

To December 1870.

Birt, W. R.

October 22, 1869. Subscriptions received after this date in our next.

NOTICES TO CORRESPONDENTS.

Several communications are unavoidably delayed.

W. T. H.—The *Monthly Notices* are published at the Apartments of the Royal Astronomical Society, Somerset House. Price to Fellows of the Society, 5*s.* per Vol.; to non-Fellows, 12*s.* The Numbers are not sold separately.

ERRATA.—Page 174, 4th line below the figure, for *it* read *A*. Page 175, lines 6 and 7, for *hyperboles* read *hyperbolas*; line 10 from bottom of page, for *on* read *at*. Page 185, line 5 from bottom, for this *line* read this *light*. Page 202, in Table of Velocities, at top of column 3, the word *feet* should be inserted, all the figures in that column being feet.

BOOKS RECEIVED.—"Astronomical Observations made at the Williamstown Observatory, Melbourne, 1861-2-3," by R. J. Ellery, Esq.—"Some Account of St. Saviour's, Southwark," by Mrs. H. Jackson Gwilt.—Also the following Publications:—"The Riverside Magazine," "The New York Times," and "The Sioux City Daily Times."

NOTICE.—Nos. 83 and 84 will be published about the end of November, the Tables for *that month* being given with the present number.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 83. DECEMBER. 1869.

CONTENTS.

PAGE
Meeting of the Royal Astronomical Society 229
Notices of New Works . . . 239
On Solar Phenomena, by Donati . 240
Spectroscopic Observations of the Sun 243
Correspondence:—
  Large Object Glasses — Delicate Astronomical Observations — Jupiter's Satellites—A Brilliant Meteor 246–248
PAGE
Brief Correspondence. . . . 248
The Planets for December . . 249
Scientific Nursery Rhymes . . 249
Discovery of Minor Planets . . 249
List of Subscribers, &c. . . . 249
Notices to Correspondents . . . 249
Astronomical Occurrences for December 250
The November Meteors . . . 252

ROYAL ASTRONOMICAL SOCIETY.

Session 1869–70.

First Meeting, November 12, 1869.

Warren de la Rue, Esq., F.R.S., *Vice-President*, in the Chair.

Secretaries—Mr. W. Huggins and Mr. E. J. Stone.

The Chairman stated he occupied that position this evening on account of the serious illness of the President, Admiral Manners, whose health, however, he felt happy to say, was now improving.

The Minutes of the last meeting were read and confirmed.

One hundred and twenty-seven presents were announced, including a valuable set of photographs of the recent solar eclipse, taken in America by Professor Meyer, and presented through the Rev. T. W. Webb; also a catalogue by Mr. Williams, Assistant-Secretary, of all the comets observed in China from 600 B.C. to 1600 A.D., and a set of stereographs of Mars from Mr. Browning. The Chairman, at the request of the President, also called attention to a most important contribution by M. LeVerrier, in which he exposes the falsity of the so-called *Pascal Letters.* The courage and skill shown by M. LeVerrier in hunting down these forgeries deserved the greatest credit.

The thanks of the Society were voted to the respective donors.

Rev. Alphonso Matthey, Lieut. W. H. Collins, R.E., and
The Rev. John Edwards,

were balloted for and duly elected Fellows of the Society.

The following papers were announced and partly read:

On his new Observatory at Chert, Surrey; by Mr. Carrington.

The author has purchased nineteen acres of land near Farnham, and there erected an observatory, of which he showed a photograph and plans of the interior. It is situated on the top of a hill 340 feet above the sea, and entirely detached, Farnham being the nearest post town. The latitude and longitude were also given. The observatory itself is sunk almost entirely in the ground, just peeping out of the soil, as there are no obstructions requiring elevation. Mr. Carrington is determined that one clock at least shall be properly mounted, and he has therefore placed it in a dry well, 6 feet in diameter and 40 feet deep. The temperature here would be invariable, and the pendulum was to vibrate in an atmosphere of uniform density. The clock has been made by Robert Bond, and communicated time to the observatory by galvanism. The principal instrument was an altazimuth on a new plan, the telescope being of 6 inches aperture and 6 feet 3 inches focal length.

The Chairman said he was sure that all present felt it a matter of congratulation that Mr. Carrington was about to commence a new career of activity. He appeared to have taken every precaution to ensure the accuracy of his normal clock, and the perfect ease and comfort of the observer. All must concur in wishing him every success.

The Chairman also remarked, that all who had read the last number of the *Monthly Notices* must have been struck with the beautiful contrivance of the Astronomer-Royal for counteracting the chromatic dispersion of the atmosphere in delicate observations; and seeing Mr. Airy present, he would ask him to supplement that paper by some description of the mode of attaching the prism to the instrument.

The Astronomer-Royal said the matter referred to embraced three different subjects, and he was afraid that most credit had been given to him for the point in which he deserved least. These subjects were, 1. The counteraction of atmospheric dispersion by another dispersion. That this might be done was obvious to everyone. 2. The calculation of the angles necessary to counteract the dispersion at different elevations; and it was for this only that he could claim any merit, as his knowledge of the indices of refraction of different glass enabled him to calculate these angles. 3. The most convenient way of making the correction. It was with great pleasure he found himself in frequent communication with an optician able to suggest, and also able to work out his suggestions. He meant Mr. Simms. The first contrivance for viewing the sun consisted of a positive eye-piece with slides of coloured glasses, and a slide of prisms of different power. The instrument he held in his hand was not the one tried by Mr. Carpenter, but a similar one, and Mr. C. had been well satisfied with the effect. Things were in this state when Mr. Simms suggested to Mr. Airy a principle which had previously been described, but never carried into practice. The object is to get the command of several prisms of different dispersive powers, and this can be done by providing a series of prisms with graduated angles; but the point arises whether it cannot be effected with one complex prism which is adjustable. If we take a plano concave lens with a convex one fitting into the concavity, by slanting the latter more or less in the cavity we obtain a prism of any angle. When this was shown to Mr. Airy he observed that, having lenses in the eye-piece, it would be well to make them do all the work they could. He therefore got a concavity cut in the field-glass, and put the tilted lens in it. He now further found that there was no necessity for an extra lens at all, and that tilting the field-glass alone into a lower and slanting position did all that was required. Such an eye-piece was now exhibited. It had occurred to the Astronomer-Royal, however, that this alteration might have an effect on the correction for spherical aberration of the different pencils of light. This was a difficult matter to calculate, and he could not speak on the subject yet. Mr. Simms had made a rough trial of the apparatus, but was not quite satisfied on the point. Thus this simple principle did the work of the usual eye-glass, field-glass, and prism in front; but in the latter plan, the spherical aberration correction was not disturbed, and the chromatic dispersion was counteracted with only the loss of a little light through the prism, and the problem completely solved.

Mr. Airy further stated that, with regard to the transit of Venus, he wished to make two remarks. The one was, that he was endeavouring to collect telescopes for the expedition, and wished, if possible, to have a 6-inch and a 4-inch telescope at each station. He had not got enough at present, and was ready to purchase 6-inch glasses, if fine ones. The other point was, that he wished to elicit from Mr. Huggins and the Chairman their opinions whether, with the coming transit, it would be best to go on as Capt. Cook did before, with ordinary eye observations, or to rely on photography or the spectroscope. In the recent American eclipse, it is said that the approach of the moon to the sun was detected by the shortening of one of the lines of the chromosphere, which disappeared altogether before any visible impression was made by the moon on the sun's disc. Now he wished to know whether it would strike Mr. Huggins as a difficulty that, whereas with the moon the point of approach was accurately known, and even if it were not, an error of a minute or more would not be of any consequence with so large a body, in the case of Venus the point of appulse was a matter of some uncertainty, and a similar error would lead to pointing the instrument off the planet altogether, and thus the shortening of the line might not be seen at all, and the observation of contact lost.

Mr. Huggins said that the Astronomer-Royal had clearly indicated what he considered to be the chief difficulty in applying the method so successful with the eclipse of the sun to the observation of the transit of Venus. There were two modes in which the spectroscope might be used. In the first, the slit of the spectroscope was to be placed in the line joining the centres of the sun and Venus, then the bright line of the chromosphere would be seen to be gradually blotted out as the planet approached the sun, and thus the observer would be prepared for noting its total extinction at the actual contact. Perhaps the bright line might not be quite extinguished, as bright lines are sometimes projected on the sun's surface, but as a continuous spectrum of the sun's limb would be seen at the same time, the exact appulse could still be determined. If the exact point of contact were accurately known, this would be an excellent method of observing; but should the instrument, from any uncertainty as to this point, be directed a little on one side, the blotting out may be too late. Even should this happen, the observation might possibly still be utilised. For the interval between the blotting out and the reappearance of the root of the bright line would enable the computation to be made how far the direction of the slit deviated, and so the true time of contact would be ascertained. The probability of error in placing the slit would be much lessened by making the sun's image as small as possible, for then the slit of the spectroscope would take in a larger piece of the sun's limb. This method promises well. The second method would be to have the slit widely opened and placed tangentially, then the observer might see the bright limb of the sun and a visible glow of light beyond it. This would be seen to be partially eclipsed by the approaching limb of Venus. The principal observation would be of the ordinary kind, but the observer would be prepared for it by the extinction of the projecting red flames. It is so much easier to observe phenomena when prepared for them. Mr. Huggins conceived the great advantage of using the spectroscope to consist in this preparation of the observer, whether the slit be placed tangentially or in the way first described. As the prominences all varied extremely in height, the only use of the extinction of the bright line at the end further from the sun's limb would be to prepare the observer for the moment of its extinction at *its root*, or, as it is sometimes, a little projected, at the point where it was seen to be crossed by the spectrum of the limb. The second method shows a considerable arc of the sun's limb, and allows for want of knowledge of the exact point of appulse, but if the tables are accurate enough to give this point with certainty, the plan first described would be the best.

Professor Cayley desired to ask a question as to the construction, with regard to form, of the adjustable prism. A cylinder, if cut diagonally and revolved, would act as a prism of any angle. This was a perfectly well-known form.

The Astronomer-Royal: I understand the spherical form is preferred as being more easily worked, but the matter may be worth consideration.

Mr. Browning: If the prism be placed outside the eye-piece it will not matter whether the material be as bad as window or ordinary plate-glass, as it will exercise no evil influence on the images.

Mr. Stone enquired at what angular distance from the sun we might expect the bright line of the chromosphere to disappear?

Mr. Huggins: The average extent of the chromosphere is about 10″ of arc.

Mr. Stone: What we are looking after is a fraction of a single second. I am afraid this plan will lead to a series of errors worse than those hitherto known.

Mr. Huggins: But you will be able to see the sun's limb at the same time.

Mr. Stone: Another difficulty is, that the exact point of appulse will be wanted in order to put the spectroscope in the line of the direction of the approaching planet. This requires the knowledge of the exact R. A. and Parallax. I shall be very glad to see the other observations supplemented by those referred to, but very sorry to rely on them alone.

Mr. Proctor pointed out that the spectroscopic mode of observing would require a different selection of stations to those which would be best otherwise; as the slanting direction in which Venus approached the limb made a difference and a difficulty.

Mr. Huggins: The slit can be turned in the direction in which the planet is moving, and the bright line will be seen in that direction.

Mr. Proctor: But we do not know the exact direction.

Mr. Huggins: That is the real difficulty I felt.

Mr. Proctor: The introduction of fresh stations will create much difficulty.

The Chairman: I will confine my remarks to what I know most about, that is, the application of photography to the observations in question. My opinion of the value of this method is confirmed by the report of Professor Meyer, who photographed the eclipse of August this year in America. He used an instrument slightly modified from the photoheliograph I took to Spain, and the results are most admirable. He states that the times were taken to the fraction of a second; the instant of slit exposure being marked on a chronograph. In this plan we do not care if the first contact be lost. Several or a hundred pictures may be taken during the transit and gone over at leisure. No eye observations can compare with these in point of accuracy. Allusion has sometimes been made to the apparent projection of a prominence on the limb of the moon, and Mr. Huggins has pointed out such a case on one of these photographs. It should be remembered that the action of the brilliant portion is progressive and continuous for 5 or 6 seconds, but the time is determined by the development of the corona, which is always a little in arrear.

Capt. Noble remarked that he would repeat what he had said on the occasion of the exhibition of the Aden photographs, that he thought accuracy impossible if one impression goes on by degrees while the other is instantaneous.

The Chairman: The moon's action goes on for 5 or 6 seconds but the sun only takes the 500th of a second, so that the blotting out of any portion is instantaneous.

The Astronomer-Royal desired to complete his answer to Professor Cayley's question, and to give a further reason for not adopting the construction he proposed. In the cylindrical form the plane of the composite refraction would be perpetually changing. It would therefore be necessary to have two movements, which would render the thing too complicated.

On the November Star Showers, 1869; by Mr. Alex. Herschel.

This paper was illustrated by a table, or diagram, collecting into one view the results of observations in the years 1866-7, and 8. It also pointed out the various times at which the best views might be expected, especially the early hours of Sunday next, and referred to the irregularities which had been noticed, and which might be due to physical causes or peculiarities in the stream itself. Mr. Herschel also described a fine meteor seen at Hawkhurst.

The Chairman remarked that, having regard to the uncertainty in time, the only course appeared to be that a watch should be maintained from to-night till Monday.

The Chairman said that he ought to call attention to the publication of Major Tennant's Report on the Eclipse of August, 1868, some copies of which were on the table, and which would shortly be in the hands of the Fellows. The expedition was, as had been before stated, *a brilliant success*, notwithstanding anything that might be said to the contrary.

On the application of Photography to the determination of the Solar Parallax from the Transits of Venus: by Mr. Proctor.

In giving an oral account of this paper, illustrated by diagrams, the author stated that it was impossible to read Mr. De La Rue's paper without feeling that the process described offered the best possible means of determining the sun's distance, and that it would doubtless be applied in 1874. The great excellence of it consisted in the fact that a number of pictures could be taken and examined at leisure afterwards, giving the measures required with extreme accuracy. Major Tennant had also written some comments on the paper, pointing out what would be the most favourable circumstances for the application of photography, but Mr. Proctor thought one point which had occurred to him had not been sufficiently considered. This was the fact that the images of the planet would not be seen side by side, but in a slanting line, and the relation of this direction to a fiducial line would produce a different effect. He then, by means of his diagrams, entered at length upon this subject, and showed how any discrepancy in the results could be obviated. In conclusion, he pointed out that the southern stations were invaluable for this method if combined with observations in Northern India; but if the latter failed, we must depend entirely on the Russian work in Siberia for corresponding observations.

Mr. Stone would only say he desired to recall to the meeting what had to be done. The parallax until recently had been taken at 8″·5, but it had been shown, from the discussion of the moon's parallactic inequality, that this must be increased, and two determinations, differing only in the value given to the moon's semidiameter, gave a mean result of 8″·88. Observations of Mars made at the Cape of Good Hope, when compared with those at Greenwich, produced 8″·93, and with those at Pulkowa 8″·96. A later discussion of these observations and others gave a mean result of 8″·86. A third method founded on the parallactic inequality of the earth's motion, due to Le Verrier's investigation, gave 8″·95. This mode required a knowledge of the moon's mass, which depended on nutation, the value of which was about the same as the parallax. From the old transits of Venus he (Mr. S.) had deduced 8″·9 for the solar parallax, and he could deliberately say that no value which did not satisfy his equations could be admitted. In the former discussions of the transit observations, the residuals were 30 times as great as his. A German writer had said that the observers at Otaheite in 1769 saw the real contacts, but the observers themselves distinctly say they did not. Here then, by four methods, we get the value between 8″·86 and 8″·96, to say nothing of that due to the measure of the velocity of light; and it is this extreme difference of 1-10th of a second which 1874 has got to settle.

Mr. Proctor: Does not this statement show the great importance of observing the transit of 1874? We know what to look for, and this will greatly reduce the limits of error.

Mr. Stone: No doubt the observations will be better this time, but unfortunately the error is due to irradiation, and observations are still very difficult on this account. Probably we have made a great step in advance by procuring better definition in our instruments, which will go far towards settling the question; but we must not expect extreme accuracy. I hope all the new methods of observation will be tried, but that the old ones will certainly not be discarded. I fear the spectroscope will land us in new difficulties as bad as any we now know. Mr. De la Rue is very sanguine as to the use of photography, and the best stations ought to be selected for its trial; but we must remember we have to deal with two or three-tenths of a second.

Mr. Proctor: Is it quite impossible to use the image of the sun thrown on a plane surface, and thus get rid of the clinging of the planet to the sun's limb?

Mr. Stone: I am afraid it is a question of optical power. Those who did not see the ligament with 90 would have seen it with a higher power. There is a paper here to-night by Dr. Robinson, narrating some experiments on irradiation, which he found to amount to 3″. I may observe that with very dark glasses, at the transit of Mercury, the sun's limb was seen quite clear, but on removing the shade it was found the planet had really cut off a part.

Mr. Howlett: I had a delicious view of the transit of Mercury by projection. I saw the thick ligament, but not the fine one. The power used was 120—the sun about 4 feet in diameter, and Mercury beautifully distinct.

Mr. Stone: I think the transit of 1848 was observed projected on paper by Mr. Main.

On a change in Colour of the Equatorial Belt of Jupiter; by Mr. Browning.

During several years the author has observed Jupiter with telescopes of large aperture, and always found the cloudy belts without colour until this year; but lately the equatorial belts have become greenish yellow, or ochrey in tint, forming a marked contrast to those above and below. The colour is exactly that called *yellow lake* by artists. Mr. Browning exhibited a very beautiful drawing of the planet, and read some of his observatory notes on the subject in corroboration. On October 9, 1869, two or three persons, unused to telescopic observation, independently set down the belt as between yellow and brown, and six out of ten present called it yellow. On October 10 Mr. Proctor saw the same thing, with the addition of white spots all over the belt. The poles were ashy blue. He also read an extract from a letter of a friend at Lewisham, calling attention to the "lovely-tinted green belt." Two years ago Mr. Browning saw Mr. De la Rue's coloured drawing of Jupiter, in which the belts are quite colourless. He watched all night and the colour remained unchanged, showing that it encircles the planet. Some years ago Mr. Huggins sent some drawings to the Society with coloured belts which afterwards disappeared, but which Mr. Huggins thought would recur. They would now be compared with the recent one. In writing to Mr. Proctor, the author had suggested that the small specific gravity of Jupiter might be due to the depth of cloud, which is what we measure. Mr. Proctor replied that perhaps we did not get all the light Jupiter gave out; and this induced Mr. Browning to set about making a complete map of the spectrum of Jupiter, in which Mr. Huggins had previously found some lines not due to the reflected light of the sun.

Note on the floor of Plato: by Mr. W. R. Birt.

During the last 48 years there have been noticed at various times white spots on the floor of Plato. The author had collected these observations, forming 56 series. The greatest number seen at once has been 7, observed by Gruithiusen. Mr. Pratt, of Brighton, has since seen 11, but not all together, and 4 of these are new ones. Mr. Crossley, of Halifax, has directed his assistant, Mr. Gledhill, to observe these spots and has sent a great number of observations to Mr. Birt. From 297 observations the author had constructed the tables he gave both of the spots and their degree of visibility. The total number of spots recorded is 26, of which 12 have been seen during one watch, but not all at once. The author also showed a drawing of the markings on this crater, which are probably permanent, but not always visible.

On the Eclipse of the Sun, August 7, 1869: by Mr. Paine.

On the same: by Lieut. Ashe.

On some attempts to render the prominences round the Sun visible: by Mr. De la Rue.

Suggestions for a method of imitating the Transit of a Planet: by Dr. Robinson.

Occultations observed at Leyton: by Mr. Talmage.

On the Lunar Eclipse of July 23 and 24, 1869: by Mr. Tebbutt, junr.

Selenographical Notes on the Apeninnes and adjacent regions: by Mr. Weston.

On the American photographs of the Solar Eclipse, 1869: by the Rev. T. W. Webb.

The series of photographs presented to the Society from Professor Meyer, having been sent direct to Somerset House, Mr. Webb had not seen them himself, but communicated such particulars respecting them as were contained in the letter to him. Three American expeditions had been sent out, the one under Professor Meyer being stationed at Burlington, Iowa. The telescope was of 6·46 inches aperture, mounted equatorially. The image was enlarged to 2 inches by a negative eye-piece, containing a reticle of wires which is shown in the pictures. The slit in the covering plate is $\frac{1}{20}$th of an inch wide, and it flashes across the field in the 500th of a second. During the totality the full aperture was used, and 5 pictures taken in the two minutes it lasted. The times of exposure were noted by a chronograph.—Some further remarks respecting the several pictures were also given.

The Chairman said that, knowing something of this subject, the meeting would permit him to speak in the highest terms of the success of these results of the American observers. They were not merely perfect specimens of photography, but a great scientific success. The larger aperture of the telescope, in comparison with that of the Spanish expedition, was a great advantage at the totality, and the more rapidly moving slide had very much improved the definition of the pictures of the partial phases. With reference to the glow round the sun and the corona generally, examination of these pictures entirely confirmed his impression that the part near the sun, at least, is really something belonging to the sun, because it is gradually covered by the moon on one side and uncovered on the other, and at distant stations it forms precisely the same pictures, which precludes the idea of its being produced by the earth's atmosphere. It certainly does not belong to the moon, as it does not follow that body. He was not here referring to the fainter and distant portions of the corona, of which he could not speak so positively. At the meeting when the Aden photographs of the eclipse in August 1868 were exhibited, Dr. Weiss stated that one of the observers found that the corona gave a continuous spectrum. Now Mr. Lockyer finds bright lines all round the sun in the spectroscope. May not these be formed by the corona? The chromosphere, as he calls it, may include both corona and protuberances. When he had examined the photographs with greater care and at leisure, he hoped to be able to make some further remarks. Commander Ashe also had sent some photographs of the eclipse from Canada. Their definition was not so good as the others, but they were useful as shewing the corona. He (the Chairman) must still urge the continued photographing of every total eclipse. The spectroscope was most useful, but it did not tell us all. There were still many things we wanted to know.

Mr. Stone: Is it not a pity that some plates are not exposed sufficiently to get the corona alone well depicted, and allow the destruction of the rest of the detail?

The Chairman: There should, if possible, be two instruments at each station, one for the purpose suggested by Mr. Stone. The paper I have sent in records some recent failures in an attempt to photograph the prominences.

The Chairman read a letter requesting subscriptions to the Faraday Memorial, and also stated that the French Academy had struck a medal in honour of the great planet-finders, Hind, Goldschmidt, and Luther, a copy of which was on the table.

The meeting then adjourned.

NEW ASTRONOMICAL WORKS.

The Midnight Sky; Familiar Notes on the Stars and Planets, by EDWIN DUNKIN. London: Religious Tract Society.

Originating in a series of papers published in the *Leisure Hour*, we have here a really excellent work on Descriptive Astronomy, Mr. Dunkin's name being at once an assurance of its interesting character and a warrant for its correctness. The principal portion of the book consists of 32 star maps, or representations of the heavens as they appear at midnight; 24 being for the latitude of London, and 8 for the Southern Hemisphere. We may, perhaps, say that we have never before come across illustrations of the heavens so like what appears at night as these maps. Here we see and recognise our favourite constellations in the positions in which we are accustomed to find them in the sky. The principal stars are given with distinctness, but no exaggeration, and the maps are not crowded with figures. The names of the stars are easily made out by means of small index maps which accompany each plate, and there is also a descriptive chapter on the constellations visible each month. The work also contains a complete treatise on the fixed stars, planets, comets, &c., and there is also an interesting account of meteors and shooting stars, which will repay perusal. The whole is illustrated with capital wood engravings, and is well printed and handsomely bound.

The illustrations to the 'Midnight Sky in the Southern Hemisphere' will be examined with much interest: the reversed positions of the constellations to the observer in that part of the world will at first be somewhat bewildering to those accustomed to these latitudes, but a little careful inspection of the maps will lead to a complete comprehension of the matter.

How to keep the Clock Right, by THOMAS WARNER. London: Williams and Norgate.

By means of a telescope with a large field of view, absolutely fixed in one position, a degree of accuracy in taking transits is obtained which no other method possesses. Mr. Warner places the telescope in such a position as to command the transit of *Vega* and other stars occupying a band of sky of about a degree and a half wide. The work under notice contains a list of the stars to be observed, and the necessary tables for reducing the observed passage of a star to mean time, for any day in the year, up to the end of the present century. With a little calculation, the possessor of a telescope, fixed in the manner described, may obtain the time with an extraordinary amount of correctness.

Stereograms of Mars, by J. Browning; *with Remarks on the same* by R. A. Proctor. London: Browning.

In a prettily got-up pamphlet of sixteen pages, with four stereoscopic slides of great beauty, we are introduced to our neighbouring planet in a manner never before attempted. As Mr. Proctor says in his introduction to these drawings, Mars is perhaps never entirely seen, but we are, by the careful observations of modern astronomers, pretty well acquainted with the markings on his surface, and are fully warranted by analogy in entitling them seas and continents.

From the drawings, chiefly of Mr. Dawes, some of which appeared in the *Astronomical Register* (September 1865), Mr. Browning constructed a globe of Mars; and from this globe these stereoscopic slides have been taken. Certainly they give a very faithful idea of what can be seen of the planet with a powerful telescope, under exceptionally favourable conditions; and, with the assistance of the accompanying chart of the planet, will enable anyone obtaining a view of Mars to decide as to the part of the planet in view at the time of observation. These stereoscopic views of Mars are quite worthy of being added to the collection of photographs of celestial objects in which astronomers now take so much pleasure.

On Solar Phenomena, in connection with other Cosmical Phenomena, a popular Lecture, by G. B. Donati, *Director of the Royal Observatory of Florence. Urbino,* 1869 *(abridged).*

In August 1612, Galileo wrote as follows in the second of his three celebrated letters concerning the spots of the sun. "For the time to come there will remain to physicists a field for speculation about the substance and manner of production of such vast masses [as are the solar spots], some of which far exceed in size all Africa and Asia, and both Americas: concerning which problem I would not venture to affirm anything certain; and would only suggest, for the consideration of speculators, how that their all falling in that band of the solar globe which lies beneath the part of the heavens which the planets traverse and wander over (and not elsewhere), affords some indication that those planets *may also have a part in such an effect.* And if according to the opinion of some famous person of ancient times, there should be ministered to so great a lamp some restoration for the diffusion of so much light, by the planets which, receiving it, move around it; assuredly as such pabulum must run by the shortest roads, it could not arrive at other parts of the solar surface." *

More than two centuries and a half have elapsed since Galileo discovered the solar spots, and astronomers and physicists have speculated and still speculate much to explain the phenomenon. Nor hitherto has the vast field opened up by Galileo been ever all occupied by followers of the same principles: nay, it has happened not unseldom that very ingenious men have attributed the solar phenomena to causes so strange and so difficult to conceive in the natural order of things, as almost to lead to the belief that besides so many other properties, the sun possesses also that of heating more than is necessary for kindling minds to the love of the truth.

---

* Second Letter of Galileo Galilei to Marca Velseri, recently published by Professor P. Volpicelli. Rome, 1860.

It is not long since astronomers have recognised the truth of Galileo's opinion that the solar spots may have some relation to the planets. The announcement by Schwabe, of Dessau, in 1843, of a maximum and a minimum of the solar spots in a period of about 10 years, was neglected till the discovery in 1857 of another fact, which revealed a relation between phenomena in the sun, and others belonging to our own globe. In 1851–52, Lamont, by a discussion of observations at Monaco, found that the mean annual variations of the magnetic needle were subject to an increase and decrease in a period of about ten years, but he did not notice the correspondence between this and the period of the solar spots.

Contemporaneously, however, with Lamont, General Sabine, who together with Hansteen is one of the most indefatigable investigators of the laws of terrestrial magnetism, on the basis of observations made under his direction at two opposite points of our globe, at Toronto and Hobart Town, accomplished for the *perturbations* of the magnetic declination what Lamont had done for the *variations*, and proved that the former also were subject to a period of about ten years, and that a like period was found as well in the inclination and in the intensity of the magnetic force. Sabine recognised that this period, observed in all the magnetic elements, precisely corresponded with that already discovered by Schwabe for the number of the solar spots.

In the summer of the same year, 1852, M. Gautier, of Genoa, and M. Wolf, of Zurich, unacquainted with each other's researches, and ignorant of the labours of Sabine, found that the period discovered by Lamont for the magnetic variation was equal to that of the solar spots, a maximum and minimum of the former corresponding respectively to a maximum and minimum of the latter.

In order, however, that this double periodicity should be accepted as a fact dependent on a cosmical order existing in nature, it was needful to review observations extending over a much longer time. This was done by M. Wolf, who, by a careful examination of very many old books and manuscripts which contained notices of the solar spots, was enabled to establish with certainty that, instead of the period of ten years indicated by Schwabe, there must be substituted a mean one of eleven years and forty days; and moreover, about every 59 years there is a much greater maximum in the spots than the intermediate maxima. A similar and isochronous periodicity was also determined for the magnetic variations.

Since the discovery of this marvellous correspondency between terrestrial magnetism and the solar spots,—another bond besides that of attraction between the sun and the earth,—further advances have been made. Schwabe thinks that in the appearance of clouds seen on the disk of Jupiter an equal period is found to that of the number of the solar spots. Wolf in 1859 arrived at results which, in general, tend to show that the variation of the distances of the planets, and especially of Jupiter, is attended within certain limits by variation in the number of the solar spots. Subsequently M. Carrington, in his work published in 1863, made a similar research, and comparing the relative number of the spots from 1750 to 1860 with the distances of Jupiter from the sun, found that as Jupiter either receded from or approached the sun, the number of the solar spots increased or diminished, so that, when the distance of Jupiter is a maximum, the number of the spots is also a maximum, and when the distance is a minimum the number is also a minimum. This correspondency, very well made out from 1770 to 1860, is not, however, equally well established from 1750 to 1770, and future observations must decide within what limits it is constant and exact.

But a relation of another kind has also been discovered between the solar spots and the positions of the planets. MM. De la Rue, Stewart, and Loewy, in a series of memoirs, from 1865 to 1868, on solar physics, have proved that the spots (apart from their number) increase in size when by means of the sun's rotation they are removed to situations more distant from the place which Venus occupies in space; and on the other hand, they decrease in extension in proportion as they approach that planet. A similar influence is exercised by Jupiter, but much less, on account, probably, of his greater distance from the sun: and Mercury, too, appears to have some such influence, but less apparent by reason of his very rapid motion. Not only the greatness of the spots, but their position also, is in part dependent on the places of the planets in space. When Jupiter and Venus are traversing the plane of the sun's equator, the spots show themselves by preference nearer the solar equator; and contrariwise, as those planets are distant from that plane, so the spots appear more remote from the equator.

It is natural to suppose that all the other planets, as well as Jupiter and Venus, exercise an influence on the solar spots depending on their distances from the sun, their masses, and, perhaps, physical constitution. Their separate effects on various accounts it is very difficult to determine, though it would seem that the action of Saturn is beginning already to be apparent. In fact, as already stated, in a period from 58 to 60 years there is a maximum amongst the maxima in the number of the solar spots. Now every 59½ years nearly, Jupiter and Saturn occupy again in space the same relative positions; so that it is very probable that the long period of 58 to 60 years, recognised in the number of the solar spots, may depend upon the simultaneous and combined action of the two above-mentioned planets.

All the facts I have treated of, which have come to light in our own days, lead us to surmise that others similar will before long be revealed, and they are of themselves a new evidence of the very great acumen of Galileo, who by merely seeing that the spots always appear not far from the plane of the sun's equator, and that the planets do not ever move far from that same plane, conjectured that the latter might have some share in the appearance of the spots themselves. [Professor Donati next proceeds to notice the views of Galileo and Newton with respect to the maintenance of the solar light and heat, and refers to the opinion expressed by Mr. Tait, and supported by Mr. De la Rue (*Researches on Solar Physics*, by De la Rue, Stewart, and Loewy: London, 1864, p. 45), and remarks that] Ingenious as these considerations are, and certainly not opposed to the principles of modern science, it appears to me that in the actual state of our physical knowledge, in order to give some explanation of the relations that exist between the planets and solar phenomena, we cannot do better than have recourse to electro-magnetic forces, which we see in action alike in the more elementary and single phenomena of the magnetic needle, as in so many other more complex and grand phenomena that occur in nature.

That the earth is a great magnet was a very ancient belief. It was maintained by W. Gilbert in 1600, and also held by Galileo. Subsequently Euler and Tobias Mayer supposed that there was a great magnet in the interior of the earth; and Hausteen found that the phenomena were better explained on the supposition of the united action of two magnets situated in the interior of the earth. Next came Gauss, who was to the system of terrestrial magnetism what Newton was to the solar system. Simply starting from the law that the magnetic force varies in inverse ratio of the squares of the distances, just as is the case with universal attraction, he investigated what in general should be the distribution and mode of acting of magnetism on the surface of a body of the same form and size as the earth; then, with the data of observation, he passed from the general case to the special case of the earth, and found a wonderful agreement between theory and experiment. It results from Gauss's investigations, that 3,954 trillions of magnetic needles, each of the force of a chilogram, and all brought together at the centre of the earth and situated in the same direction, would be capable of producing on the earth's surface a magnetic force equal to that which is actually observed. If these needles be supposed, in the next place, to be uniformly distributed in the whole body of the earth, there should be one for each cube having a side of 4½ decimetres; and since the substances forming the crust of our planet are in general either without magnetic virtue, or have it in a much smaller measure than would be the case if a needle of the force of a chilogram were found in every cube of 4½ decimetres to its side, it is necessarily inferred that magnetism is stronger in the interior than on the surface of our globe, and therefore the opinion of some is erroneous who have imagined that magnetism exists only on its surface.

In the letter I referred to in the beginning, Galileo hints at the *possibility* of magnetic virtue exercising some action upon the sun. The genius of Sir W. Herschel, in 1801, started the opinion that there might be a close analogy between the phenomena of the sun and the aurora borealis: and later his son, Sir John, developed his father's view in his *Astronomy*, first published in 1833 (ch. v., note). Thus the idea that a kind of electric correspondency may exist between the sun and the planets was already a definite one, even before the connection between the solar spots and the electro-magnetic phenomena of our globe and the positions of the other planets was recognised.

But there is more: it has been recognised that even the auroræ boreales, which are undoubtedly an electro-magnetic phenomenon of our atmosphere, have also a connection with the spots of the sun. Mr. Loomis has, in fact, proved that the number of the auroras that are seen in the one and the other hemisphere of the earth has maxima and minima that precisely correspond with the maxima and minima of the number of the spots. (*Annual Report of the Smithsonian Institution for* 1865, p. 208.)

SPECTROSCOPIC OBSERVATIONS OF THE SUN.

In resuming this subject, we continue the extracts from Mr. Lockyer's papers, part of which we gave last month:—

Since the foregoing Paper was written I have had, thanks to the somewhat better weather, some favourable opportunities for continuing two of the lines of research more especially alluded to in it. I refer to the method I had adopted for viewing the prominences and to the injection of sodium magnesium, &c. into the chromosphere.

With regard to seeing the prominences, I find that when the sky is free from haze the views I obtain of them are so perfect that I have not thought it worth while to remount the oscillating slit. I am, however, collecting red and green and violet glass of the required absorptions to construct a rapidly revolving wheel, in which the percentages of light of each colour may be regulated. In this way I think it possible that we may in time be able to see the prominences as they really are seen in an eclipse, with the additional advantage that we shall be able to see the sun at the same time, and test the connection, or otherwise, between the prominences and the surface-phenomena.

Although I find it generally best for sketching purposes to have the open slit in a radial direction, I have lately placed it at a tangent to the limb, in order to study the general outline of the chromosphere, which in a previous communication I stated to be pretty uniform, while M. Janssen has characterised it as "*à niveau fort inégal et tourmenté.*" My opinion is now that perhaps the mean of these two descriptions is, as usual, nearer the truth, unless the surface changes its character to a large extent from time to time. I find, too, that in different parts the outline varies. Here it is undulating and billowy; there it is ragged to a degree, flames as it were darting out of the general surface, and forming a ragged, fleecy, interwoven outline, which in places is nearly even for some distance, and, like the billowy surface, becomes excessively uneven in the neighbourhood of a prominence.

According to my present limited experience of these exquisitely beautiful solar appendages, it is generally possible to see the whole of their structure, but sometimes they are of such dimensions along the line of sight that they appear to be much denser than usual; and as there is no longer, under these circumstances, any background to the central portion, only the details of the margins can be observed in addition to the varying brightnesses.

Moreover, it does not at all follow that the largest prominences are those in which the intensest action or the most rapid change is going on, the action as visible to us being generally confined to the regions just in or above the chromosphere, the changes arising from violent uprush or rapid dissipation, the uprush and dissipation representing the birth and death of a prominence. As a rule, the attachment to the chromosphere is narrow, and is not often single. Higher up, the stems, so to speak, intertwine, and the prominence expands and soars upward until all is lost in delicate filaments, which are carried away in floating masses.

Since last October up to the time of trying the method of using the open slit, I had obtained evidence of considerable changes in the prominences from day to day. With the open slit it is at once evident that changes on the small scale are continually going on. It was only on the 14th inst. that I observed any change at all comparable in magnitude and rapidity to those already observed by M. Janssen.

About 9h. 45m. on that day, with a tangential slit I observed a fine dense prominence near the sun's equator on the eastern limb. I tried to sketch it with the slit in this direction, but its border was so full of detail and the atmospheric conditions were so unfavourable, that I gave up the attempt in despair. I turned the instrument round 90°, and narrowed the slit, and my attention was at once taken by the F line; a single look at it taught me that an injection into the chromosphere and intense action were taking place. These phenomena I will refer to subsequently.

At 10h. 50m., when the action was slackening, I opened the slit; I saw at once that the dense appearance had all disappeared, and cloud-like filaments had taken its place. The first sketch, embracing an irregular prominence with a long perfectly straight one, which I called A, was finished at 11h. 5m., the height of the prominence being 1′ 5″ or about 27,000 miles. I left the observatory for a few minutes, and on returning at 11h. 15m. I was astonished to find that part of the prominence A had entirely disappeared; not even the slightest rock appeared in its place. Whether it was entirely dissipated, or whether parts of it had been wafted towards the other part I do not know, although I think the latter explanation the more probable one, as the other part had increased.

We now come to the other attendant phenomena. First as to the F line. In my second paper I stated that the F line widens as the sun is approached, and that sometimes the bright line seems to extend on the sun itself, sometimes on one side of the F line, sometimes on the other.

Dr. Frankland and myself have pointed out as a result of a long series of experiments, that the widening out is due to pressure and apparently not to temperature *per se*; the F line near the vacuum point is thin, and it widens out on both sides (I do not say to the same extent) as the pressure is increased. Now, in the absence of any disturbing cause it would appear that when the wider line shows itself on the sun on one side of the F line, it should always at the same time show itself on the other; this, however, *it does not always do.* I have now additional evidence to adduce on this point, and this time in the prominence line itself off the sun. In the prominence to which I have referred the F bright line underwent the most strange contortions, as if there were some disturbing cause which varied the refrangibility of the hydrogen line under certain conditions and pressures.

The D line of hydrogen (?) also once bore a similar appearance.

Secondly, as to the other phenomena which accompanied this strange behaviour of the F line, and were apparently the cause of it.

In the same field of view with F, I recognised the barium line at 1,989·5 of Kirchhoff's scale.

Passing on, the magnesium lines and the enclosed nickel-iron line were visible in the chromosphere. The magnesium was projected higher into the chromosphere than the barium, and the nickel or iron was projected higher than the magnesium. I carefully examined whether the other iron lines were visible in the spectrum; but I did not find them, probably owing to the feeble elevation of the barium vapour above the general level of the photosphere, which made the observation in this region a very delicate one.

I detected another chromosphere line very near the iron line at 1,569·5 (on the east side of it).

The sodium lines were also visible.

Unfortunately clouds prevented my continuing these interesting observations; but the action was evidently toning down.

Here then we have an uprush of barium, magnesium, nickel, (?) and an unknown substance from the photosphere into the chromosphere, and with the uprush a *dense* prominence; accompanying the uprush we have changes of an enormous magnitude in the prominence; and as the uprush ceases the prominence melts away.

As stated in the former part of this Paper, the barium and magnesium lines were thinner than the corresponding Fraunhofer lines. In connection with this subject I beg to be allowed to state that I have commenced a careful comparison of Kirchhoff's map, with the recently published one of Angström. From what I have already seen I believe other important conclusions, in addition to that before alluded to, may be derived from this comparison; but I hesitate to say more at present, as I have not yet been able to compare Angström's maps with the sun itself, or to examine the angular diameters of the sun registered at Greenwich during the present century.

On the 14th instant I also succeeded in detecting the hydrogen line in the extreme violet in the spectrum of the chromosphere.

Here we must leave this important and interesting subject for another month. The study of these papers will show the extreme difficulty and delicacy of the observations and experiments, and the details given will enable our readers to form their own conclusions as to the reasoning of the authors whose works we quote.

CORRESPONDENCE.

N B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

LARGE OBJECT GLASSES.

Sir,—I see Mr. Whitehouse wants advice on the construction of a large object glass, 18 inches across. Happy man! I wish I was going to make one only half as big, and I don't think I should ask any one's advice about it either. But he is more than welcome to all I know.

1st. Let the glass be good. Chance's warranted first quality for telescopes; then, if it turns out defective, they will give him another and another until he is suited.

2nd. Let the focus be medium; not too long, not too short; 18 feet 3 inches is too short, it makes such deep curves and such a large residual spectrum. As this goes by angular aperture and not by mere size or length, 1 inch diameter to 15 inches of focus I think about the best proportion.

3rd. About the curves; by all means let the inner curves be practically coincident, about ·005 inch between them in the middle, just to keep dust from scratching the faces; with the density of glass which Chances make for telescopes the radii are about + 1 + 2 − 2 − 3 the + meaning a convex surface, and the crown glass having both surfaces convex, while the flint has its surfaces concave; the rays fall nearly, or, in fact, should fall *exactly* perpendicular to the last surface, which should be the same radius as the focus. There is a correction for the spherical aberration to be obtained by having them a little, a *very little* shorter; but happy is the man that makes such perfect spherical surfaces that this error shall be visible on the formula specified, therefore I don't trouble myself about such niceties of radius as that: however, let the middle and last radii be fixed, and do all the altering for chromatic correction on the front surface only, it saves a world of labour; and then don't trouble about the exact length the focus happens to come, but only get it good and be thankful.

Chiswick, W. A. DAWSON.

DELICATE ASTRONOMICAL OBSERVATIONS.

Sir,—In the supplementary number of the *Monthly Notices*, just issued, is a paper by the Astronomer Royal, on the correction of atmospheric chromatic dispersion, which may be advantageously applied in observing the physical aspect of the moon's surface. It is effected by inserting a glass prism of small refracting angle in the eye-piece of the telescope. The Astronomer Royal proposes to employ a series of flint prisms ground to the angles of 2°, 4°, 6°, 8°, 12° and 16°, arranged on a long slider, and introduced between the two glasses of the eye-piece in such a way that the edges of the prisms may be upwards in an inverting telescope. Two trials by Mr. Carpenter are given in the paper, one on Saturn, zenith distance 82°; the other on the moon, zenith distance 78°. The moon was viewed by the Altazimuth power 100, and with the prism of 6° Mr. Carpenter reported—"destroyed the colour entirely. The definition of the details about the moon's rugged edge was much improved." The Astronomer Royal says—"It is made possible, by this construction, to examine a celestial body with delicacy and accuracy, under circumstances which would, without this construction, have rendered nice observation impossible."

I am, Sir, your obedient servant,
Cynthia Villa, Walthamstow: Oct. 25, 1869. W. R. BIRT.

JUPITER'S SATELLITES.

Sir,—I hope some of your readers may have been more fortunate than myself with respect to an interesting spectacle which might have been witnessed last night—the close appulse of the 3rd satellite of Jupiter to a very minute star; perhaps even the actual occultation of the latter. Definition being fuzzy, and the air unfit for any careful scrutiny of the planet (whose peculiar colouring is now attracting my attention), I took no note of the time when I first looked at Jupiter; but it may have been within half an hour on either side of 9h. I then remarked a very small star, of perhaps 12 or 13 mag., a little W. of the 3rd satellite, which was the farthest from the planet; the distance between the two may have been some 20″. On returning to the telescope about 11h. 15m. I looked for it with the same power (110), at first in vain; after a little while, however, I detected it on the opposite side of the satellite, but much nearer than before: with 450. I estimated its distance at about 4 diameters of the satellite, which with this power appeared, notwithstanding the state of the air, as a miniature full moon. My first impression was, that an occultation must have taken place; but on further examination I thought that the path of the satellite's centre lay a little N. of the star, but whether far enough to keep clear of it I could not judge. I need not add that the phenomenon was calculated to tax the capability of a first-class instrument: I hope some such may have been directed to it in a finer air than we had here, in which I believe even Mr. Buckingham's magnificent achromatic would have done little more than my 9½-inch silvered mirror. The evidence thus incidentally obtained of the rapid retrogradation of Jupiter was very striking, the result being solely due to this cause, as the satellite was just beginning to return towards the planet from its greatest W. elongation.

I am, Sir, yours truly,
Hardwick Vicarage: Nov. 11, 1869. T. W. WEBB.

A BRILLIANT METEOR.

Sir,—Yesterday evening, whilst driving from Grantham to Sleaford, direction W. to E., and position 4 miles from the latter place, mean time nearly 7, I was astonished to see the whole country illumined instantaneously as by a magnesium light. I turned my head and saw, W. by S., a long train of light left by a splendid meteor, which was just disappearing below the horizon, and of which I only caught a glimpse; the glare of the train remained in the atmosphere on the western horizon for some seconds after the disappearance of the nucleus.

Yours obediently,

Sleaford: Nov. 7, 1869. R. W. PAYNE.

BRIEF CORRESPONDENCE.

NEPTUNE.—Should any reader of the *Register* like to have a diagram of the stars in the vicinity of Neptune, I shall be happy to send it to anyone who will enclose a postage stamp. Last year rather many expressed their satisfaction at having been enabled to identify this planet, of so great historical, though not much optical, interest.

Teignmouth, South Devon. G. J. WALKER.

CASSEGRAINIAN TELESCOPE.—What curve would the small mirror of a Cassegrainian Telescope require to be, to correct the spherical aberration of the large mirror, the dimensions being, diameter of large mirror 12 inches, and focal length 3 feet?—J. S.

ASTRONOMICAL SOCIETIES.—Will you inform me in your next number what are the objects of the *Observing Astronomical Society*, and how I can be made a member of that, and of the *Royal Astronomical Society*, and whom I must apply to. S. J. JOHNSON.

[Mr. Johnson will find an answer to the first part of his query by referring to page 165 of our number for July this year.—To become a member of the Royal Astronomical Society, he must be proposed by three fellows of the Society, to one of whom he must be personally known.]

JUPITER'S SATELLITES.—In reply to R. T. Gould, the orbits of Jupiter's satellites are not in the plane of the ecliptic; consequently it is only at two periods during one revolution of Jupiter, that their shadows are cast upon its equator. At the present time they fall far south of the equator, and six years ago they fell as far north of it, while the fourth satellite and its shadow, at such times, altogether miss the planet.

T. W. B.

MINOR PLANETS.—The only one which seems to come within the conditions given by W. T. Holden, amongst the five whose places are found in the *Nautical Almanac* for 1870, is Ceres.

	R.A.		Decl.		Merid. passage.	
1869.	h.	m.	°	′	h.	m.
Nov. 27	3	33	12	37	11	5
Dec. 7	3	24	12	47	10	17
17	3	17	13	6	9	31
27	3	12	13	34	8	47
37	3	10	14	11	8	5

As Ceres shines like a star of the 8th magnitude, it is easily seen with such a telescope as Mr. Holden's.—G. J. W.

METEORS.—Is there any list of all the known radiant points of meteor showers, with the dates when they appear?—T. W. B.

THE PLANETS FOR DECEMBER.

AT TRANSIT OVER THE MERIDIAN OF GREENWICH.

Planets	Date	Right Ascension			Declination		Diameter	Meridian Passage	
		h	m	s	°	′		h	m
Mercury	5th	16	34	57	− 22	36½	4″·6	23	33·8
	20th	18	11	20	25	14	4″·6	0	14·9
Venus	5th	20	13	48	− 22	31½	22″·6	3	16·0
	20th	21	15	53	17	42	26″·7	3	18·9
Jupiter	5th	2	41	52	+ 14	26½	44″·7	9	43·0
	20th	2	37	19	14	9½	43″·2	8	39·5
Uranus	5th	7	32	50	+ 22	13½	4″·2	14	36·2
	20th	7	30	33	22	19	4″·2	13	32·8
Neptune	5th	1	4	58	+ 5	5½	—	8	6·3
	20th	1	4	30	5	3½	—	7	6·0

SCIENTIFIC NURSERY RHYMES.

◆

Wrinkles, wrinkles, solar star,
I obtain of what you are,
When, unto the noon-day sky,
I the spectroscope apply.

For the spectrum renders clear
Gaps within your photosphere;
Also sodium in the bar, [star.
Which your rays yield, solar

DISCOVERY OF THE MINOR PLANETS.—Mr. Hind has received a Medal from Paris in recognition of his services to Science by the discovery of so many of these small bodies.

LIST OF SUBSCRIBERS—Names received since our last number.

Broome, Rev. J. H., Houghton Hall, Rougham.
Warner, Thomas, Esq., 47, Sussex Square, Brighton.

ASTRONOMICAL REGISTER—SUBSCRIPTIONS RECEIVED.

To December, 68.
Barkas, T.P
To September, 69.
Birmingham, J
Gwilt, Mrs
To December, 69.
Bagnall, J.N
Court, J
Denning, W.F
Elliott, R
Jenkinson, Rev. J.H
Lawton, W
Locke, W
Noble, Capt. W
Payne, R
To January, 70.
Lewis, H.K
To March, 71.
Warner, T
To December, 71.
Jones, W. E

Nov. 24, 1869.—Subscriptions after this date in our next.

TO CORRESPONDENTS.

Several Communications are unavoidably deferred.—We are preparing No. 84 as a Supplementary Number, in order to complete the twelve numbers for the present year.

ASTRONOMICAL OCCURRENCES FOR DECEMBER, 1869.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	1		Sidereal Time at Mean Noon 16 41 31·1	1st Ec. R.	6 11 54	Jupiter. — 10 0·3
Thur	2	10 32 22 41	Conjunction of Moon and Mercury 4° 30′ S. ● New Moon			9 56·0
Fri	3	10 43	Conjunction of Moon and Saturn 2° 7′ S.	3rd Oc. D. „ Oc. R. „ Ec. D. „ Ec. R. 2nd Oc. D.	6 16 8 7 8 55 12 10 42 27 14 56	9 51·7
Sat	4	16 0	Conjunction of Moon and Mars 3° 5′ S.	1st Oc. D.	16 19	9 47·3
Sun	5		Meridian Passage of the Sun, 9m 5s before Mean Noon	2nd Tr. I. „ Sh. I. „ Tr. E. „ Sh. E. 1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	9 17 10 37 11 34 12 58 13 36 14 17 15 47 16 29	9 43·0
Mon	6	17 12	Conjunction of Moon and Venus 2° 14′ S.	1st Oc. D. „ Ec. R.	10 46 13 38 36	9 38·7
Tues	7	7 57	Occultation, disappearance of 20 Capricorni(6)	2nd Oc. D. „ Ec. R. 1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	4 4 7 48 16 8 2 8 46 10 13 10 58	9 34·4
Wed	8	5 36 6 35	Occultation, δ Capricorni (3) Reappearance of ditto	1st Oc. D. „ Ec. R.	5 12 8 7 28	Moon. — 4 27·8
Thur	9			1st Tr. E. „ Sh. E.	4 40 5 27	5 14·1
Fri	10	11 12	☽ Moon's First Quarter	3rd Oc. D. „ Oc. R. „ Ec. D. „ Ec. R.	9 39 11 34 12 57 40 14 44 52	5 58·0
Sat	11	1 8	Conjunction of Saturn with the Sun			6 40·1
Sun	12	0 8	Conjunction of Saturn and Mercury 2° 26′ S.	2nd Tr. I. „ Sh. I. „ Tr. E. 1st Tr. I. 2nd Sh. E. 1st Sh. I.	11 37 13 15 13 56 15 22 15 37 16 12	7 21·5
Mon	13	5 0 15 42	Superior Conjunction of Mercury Greatest Easterly Elongation of Venus 47° 17′	1st Oc. D. „ Ec. R.	12 33 15 34 15	8 2.9
Tues	14	9 21 10 15 18 43	Occultation of ξ^2 Ceti (4) Reappearance of ditto Conjunction of Moon and Jupiter 4° 5′ N.	3rd Sh. E. 2nd Oc. D. 1st Tr. I. 2nd Ec. R. 1st Sh. I. „ Tr. E. „ Sh. E.	5 2 6 22 9 48 10 23 58 10 41 12 0 12 53	8 45·3

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	15		Illuminated portion of disk of Venus=0·496 of Mars=0·986	1st Oc. D. „ Ec. R.	7 0 10 3 9	Moon. — 9 29·5
Thur	16		Sidereal Time at Mean Noon 17 40 39·5 Meridian Passage of the Sun 4m 1s before Mean Noon	1st Tr. I. 2nd Sh. E. 1st Sh. I. „ Tr. E. „ Sh. E.	4 15 4 56 5 10 6 27 7 22	10 16·1
Fri	17	15 12 15 59	Occultation of *m* Tauri (4) Reappearance of ditto	1st Ec. R. 3rd Oc. D. „ Oc. R.	4 32 8 13 5 15 5	11 5·5
Sat	18	10 27 11 42 11 50 16 1 16 45	Occultation of χ^1 Orionis Reappearance of do. (4½) ○ Full Moon Occultation of χ^4 Orionis Reappearance of do. (5)			11 57·7
Sun	19	17 27 18 27	Occultation of ζ^2 Geminorum (4) Reappearance of ditto Saturn's Ring: Major Axis=34″·05 Minor Axis=15″·41	2nd Tr. I. „ Sh. I.	14 0 15 54	Jupiter. — 8 43·6
Mon	20	7 13 23 28	Conjunction of Moon and Uranus 1° 11′ N. Conjunction, Venus and ι Capricorni (4m·1) W.	1st Oc. D.	14 21	8 39·5
Tues	21	9 39 10 32	Occultation of δ Cancri (4) Reappearance of ditto	3rd Tr. E. „ Sh. I. 2nd Oc. D. 3rd Sh. E. 1st Tr. I. „ Sh. I. 2nd Ec. R. 1st Tr. E. „ Sh. E.	5 0 7 0 8 43 9 3 11 36 12 36 12 59 41 13 48 14 48	8 35·3
Wed	22			1st Oc. D. „ Ec. R.	8 48 11 58 56	8 31·2
Thur	23	16 22 17 29	Occultation of *l* Leonis (5) Reappearance of ditto	2nd Sh. I. „ Tr. E. 1st Tr. I. „ Sh. I. 2nd Sh. E. 1st Tr. E. „ Sh. E.	5 12 5 31 6 3 7 5 7 34 8 15 9 17	8 27·1
Fri	24			1st Ec. R.	6 27 56	8 23·0
Sat	25	14 33	☾ Moon's Last Quarter			8 18·9
Sun	26					8 14·9
Mon	27					8 10·8
Tues	28			3rd Tr. I. „ Tr. E. „ Sh. E. 2nd Oc. D. 3rd Sh. E. 1st Tr. I. „ Sh. I.	6 32 8 37 11 2 11 6 13 5 13 25 14 31	8 6·8

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	29	8 23	Conjunction, Venus and μ Capricorni (2m·1) W.	1st Oc. D.	10 37	Jupiter.
				,, Ec. R.	13 54 47	8 2·7
Thur	30			2nd Tr. I.	5 38	7 58·7
				,, Sh. I.	7 51	
				1st Tr. I.	7 52	
				2nd Tr. E.	7 58	
				1st Sh. I.	9 0	
				,, Tr. E.	10 4	
				2nd Sh. E.	10 13	
				1st Sh. E.	11 13	
Fri	31	1 42	Conjunction, Moon and Saturn 1° 55′ S.	1st Oc. D.	5 5	7 54·7
				,, Ec. R.	8 23 49	

THE NOVEMBER METEORS.

◆

The display of meteors this year, which, from the calculations of those who have given attention to the subject, was to have been as great as that of 1866, has unfortunately been almost entirely invisible to us from the most unfavourable weather. Although a few were seen on the morning of the 14th, rain, cloud, mist, and fog have generally conspired to prevent any view of the star-shower, if it took place on a scale in accordance with the predictions of astronomers. Several remarkable detached shooting-stars have, however, been seen and described by correspondents in the newspapers, and of one, which was seen on November 6, in which case a meteoric stone is stated to have been picked up, we give the following account, from the *Standard* :—

> The second meteor was seen by, I know, four different persons, who thought it fell in the rectory grounds (it has since been found in the field beyond.) They compare it to a ball of fire, first of a bluish colour, changing as it fell to a deep orange, but leaving no sparks behind ; this also gave a brilliant light. It was picked up on the Wednesday following by Mr. Slightam, who says it had then a strong sulphurous smell. It is an object of much interest to the people here.
>
> I am afraid of making my communication too long, so I will simply say its outward appearance is similar to those generally known as meteoric stones, but the upper part (that is, as it lay on the ground) had a piece seemingly blown off, and this shows the interior to be a pure flint of a brownish tinge : lying on this is a fine powder in crystals, like silica ; others more needle-shaped ; then also metallic grains are visible—nickel, I suppose. There is also a projection, which has the appearance of a broken fossil shell of the mussel class ; but this we wish to have examined, and to do that the stone must be broken or cut open more than it is at present ; for, should it prove to be such, it would go a long way to establish the theory of meteoric stones being part of a dismembered world. In size it is less than a cricket ball, and weighs more than one lb. avoirdupois. It must have been in a soft state when it reached the ground, for it had not penetrated more than half an inch, and that part is much flattened and smoother than the rest.—I am, Sir, yours respectfully,
>
> Fawley, near Southampton, Hants, Nov. 16. A. T. SMITH.

The Astronomical Register is intended to appear at the commencement of each month ; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. GORTON, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**

The Astronomical Register.

No. 84. SUPPLEMENTARY NUMBER. 1869.

CONTENTS.

Spectroscopic Observations of the Sun 253
The Lunar Surface 256
Mr. Birt's New Lunar Map . . 256
Notes on the Wonders and Beauties of the Starry Heavens 257
The Moon: its Motion and Physical Constitution Examined . . . 260

APPENDIX: The Signs of the Zodiac, Rev. J. H. Broome.
Title-Page and Index for Vol. VII. 1869.

SPECTROSCOPIC OBSERVATIONS OF THE SUN.

On April 14, 1869, Mr. Lockyer presented his paper No. IV. with the above title to the Royal Society, containing his conclusions derived from observations made on the 11th of that month, in the neighbourhood of a fine spot not very far from the sun's limb.

I. Under certain conditions the C and F lines may be observed *bright on the sun*, and in the spot spectrum also, as in prominences or in the chromosphere.

II. Under certain conditions, although they are not observed as bright lines, the corresponding Fraunhofer lines are blotted out.

III. The accompanying changes of refrangibility of the lines in question show that the absorbing material moves upwards and downwards as regards the radiating material, and that these motions may be determined with considerable accuracy.

IV. The bright lines observable in the ordinary spectrum are sometimes interrupted by the spot spectrum, i.e. they are only visible in those parts of the solar spectrum near, and away from, spots.

V. The C and F lines vary excessively in thickness over and near a spot, and on the 11th, in the deeper portion of the spot, they were much thicker than usual.

VI. Stars, in the spectrum of which the absorption lines of hydrogen are absent, may either have their chromospheric light radiated from beyond the limb, just balanced by the light absorbed by the chromosphere on the disk, or they may come under the condition referred to in II., either absolutely or on the average.

In an addendum to this paper, received April 29, the author continued the detail of his observations and results.

Since the date on which the foregoing paper was written, I have obtained additional evidence on the points referred to. I beg, therefore, to be permitted to make the following additions to it.

The possibility of our being able to determine the velocity of movements of uprush and downrush taking place in the chromosphere depends upon the alterations of wave-length observed.

It is clear, therefore, that a mere uprush or downrush at the sun's limb will not affect the wave-length, but that if we have at the limb cyclones, or backward or forward movements, the wave-length will be altered so that we may have,—

1. An alteration of wave-length near the centre of the disk caused by upward or downward movements.
2. An alteration of wave-length close to the limb, caused by backward or forward movements.

If the hydrogen lines were invariably observed to broaden out on both sides, the idea of movement would require to be received with great caution; we might be in presence of phenomena due to greater pressure, both when the lines observed are bright or black upon the sun; but when they widen out sometimes on one side and sometimes on the other, and sometimes on both, this explanation appears to be untenable, as Dr. Frankland and myself, in our researches at the College of Chemistry, have never failed to observe a widening out on both sides the F line when the pressure of the gas has been increased.

On the 21st I was enabled to extend my former observations. On that day the spot, observations of which form the subject of the paper, was very near the limb. As this was the first opportunity of observing a fine spot under such circumstances I had been able to utilise, I at once commenced work upon it. The spot was so near the belt that its spectrum, and that of the chromosphere, were both visible in the field of view.

The spot-spectrum was very narrow, as the spot itself was so greatly foreshortened; but the spectrum of the chromosphere showed me that the whole adjacent limb was covered with prominences of various heights, all blended together.

Further the prominences seemed fed, so to speak, from apparently the preceding edge of the spot, for both C, F, and the line near D *were magnificently bright on the sun itself*, the latter especially striking me with its thickness and brilliancy.

In the prominences, C and F were observed to be strangely gnarled, knotty, and irregular, and I thought that some "injection" must be taking place. I was not mistaken. On turning to the magnesium lines I saw them far above the spectrum of the limb, and unconnected with it.

A portion of the upper layer of the photosphere had, in fact, been lifted up beyond the usual limits of the chromosphere, and was there floating cloudlike.

The vapour of sodium was also present in the chromosphere, though not so high as the magnesium, or unconnected with the spectrum of the limb, and, as I expected, with such a tremendous uplifting force, I saw the iron lines (for the first time) in the spectrum of the chromosphere.

The paper goes on to describe with great minuteness the changes in the spectra on that and subsequent days; the various appearances of the prominences and lines being shown by drawings, which we are compelled to omit, as also those detailed observations.

The next paper received by the Royal Society was entitled *Researches on Gaseous Spectra in relation to the Physical Constitution of the Sun, Stars, and Nebulæ*, second note. By Dr. Frankland and Mr. Lockyer. It is dated May 5, 1869, and contains the following statements of their further results:—

> I. The Fraunhofer line on the solar spectrum, named *h* by Angstrom, which is due to the absorption of hydrogen, is not visible in the tubes we employ with low battery and Leyden-jar power; it may be looked upon, therefore, as an indication of relatively high temperature. As the line in question has been reversed in the spectrum of the chromosphere, it follows that the chromosphere, when cool enough to absorb, is then of a relatively high temperature.
>
> II. Under certain conditions of temperature and pressure, the very complicated spectrum of hydrogen is reduced in our instrument to *one line in the green* corresponding to F in the solar spectrum.
>
> III. The equally complicated spectrum of nitrogen is also reducible to one bright line in the green, with traces of other more refrangible faint lines.
>
> IV. From a mixture of the two gases we have obtained a combination of the spectra in question, the relative brilliancy of the two bright green lines varying with the amount of each gas present in the mixture.
>
> V. By removing the experimental tube a little further away from the slit of the spectroscope, the combined spectra referred to in II. and III. were reduced to the two bright lines.
>
> VI. By reducing the temperature all spectroscopic evidence of the nitrogen vanished; and by increasing it many new nitrogen lines make their appearance, the hydrogen line always remaining visible.
>
> The bearing of these latter observations on those made on the nebulæ by Mr. Huggins, Father Secchi, and Lord Rosse is at once obvious. The visibility of a single line of nitrogen has been taken by Mr. Huggins to indicate possibly, first, "a form of matter more elementary than nitrogen, and which our analysis has not yet enabled us to detect;" and then, secondly, "a power of extinction existing in cosmical space."
>
> Our experiments on the gases themselves show not only that such assumptions are unnecessary, but that spectrum analysis here presents us with a means of largely increasing our knowledge of the physical constitution of these heavenly bodies.
>
> Already we can gather that the temperature of the nebulæ is lower than that of our sun, and that their tenuity is excessive; it is also a question whether the continuous spectrum observed in some cases may not be due to gaseous compression.

This was the last communication received from the authors before the recess; but a long and interesting letter from Lieut. J. Herschel to Mr. Huggins, dated May 7, 1869, was read on June 10. The necessity for closing the present series of articles in the present number of the *Astronomical Register* prevents our giving this *in extenso*, which we much regret on account of the graphic manner in which the writer describes his further experiments. The omission is, however, of the less consequence, as although in it Lieut. Herschel announced that he had succeeded in seeing the actual prominences, some of which he depicts, he afterwards found that he had been anticipated by Mr. Lockyer. It will, however, be desirable to give Lieut. Herschel's table of the bright lines seen by him in the prominences.

α=C	Kirchhoff's	694
β=F	„	2,080
δ near D	„	1,014 nearly
γ near G	„	2,796
ϵ near C	„	655 about
ζ between F and G	„	2,596 nearly

The magnesium lines cannot be detected by this observer. Here, then, we must leave the subject for the present, merely remarking that the new session of the Royal Society has already produced further important contributions, which we trust, at some future opportunity, to bring under the notice of our readers.

THE LUNAR SURFACE.—There are very few really good representations of the surface of our satellite; in fact, although it seems quite easy, it is really very difficult to draw the appearances of the craters; the variations of light and shade, beautifully distinct to the eye, disappear under the touches of the pencil. Photography does not help much here, the sharpest negatives, when sufficiently magnified to be useful, give but indistinct pictures of what is so bright and crisp when seen in the telescope. The best representations of lunar scenery we are acquainted with are those produced by Mr. Nasmyth, who, from repeated observations, makes the most beautiful models in plaster of the craters and other objects on the lunar surface. These models, when placed in a suitable light, at the proper angle of illumination, are perfect reproductions of the moon itself. Photographs taken from these models are by far the best illustrations of the lunar craters which we have ever seen. We had the pleasure, some time ago, of visiting Mr. Nasmyth, and derived great gratification from observing the very careful and effective manner in which he produced these excellent casts.

MR. BIRT'S NEW LUNAR MAP.—It appears that the necessary funds for completing the large lunar survey commenced by Mr. Birt under the auspices of the British Association, and of which four areas, each of five degrees of longitude and latitude, are completed, are not yet subscribed. The number of lunar objects now registered is 2,027; and Mr. Birt has also published a map of the Mare Serenitatis, with its craterology and principal features, accompanied by so complete a descriptive text that any intelligent amateur, wishing to study the moon's surface, would be able to identify the localities. The prosecution of the map is much to be desired. We hear some talk of a Selenographical Society, in which, as in the Palæontographical and some others, every member would pay his guinea, and thus furnish the means. The time seems opportune, for there is a whisper of a discovery which, by correcting the "residual aberration" in the microscope and telescope, will enable observers to see the infinitely small and the infinitely distant with greater clearness and precision than ever.—*Athenæum.*

NOTES ON THE WONDERS AND BEAUTIES OF THE STARRY HEAVENS.

By C. Grover.

No. 2. The Constellation Cassiopeia.

In continuation from the *Register* for August 1868, we resume with a constellation easily known from the configuration of its principal stars, which have been likened to the letters M or W, according as they are situated above or below the Pole. It is generally represented on globes and maps by the figure of a female seated in a chair, and placed head towards the Pole, so that she appears to be carried by the diurnal movement of the heavens headlong around the celestial centre. The Milky Way crosses the southern portion of the constellation, containing many beautiful fields and some fine clusters. The asterism extends a long way north of the principal stars into a region sprinkled over with minute points, among which identification by the naked eye is difficult. The richness of the region will, however, well repay the trouble of the search.

The observer, using an achromatic telescope, will scarcely need to be reminded that the most convenient period for viewing this and other similarly situated constellations is when they are situated either east or west of the Pole, since, when on the meridian above the Pole, their great altitude necessitates an amount of neck-twisting, not only uncomfortable to the observer, but obviously likely to cause erroneous notions of the positions of the objects so observed; and when below the Pole they are obscured by the vapours of the horizon. In using the Newtonian reflector the attitude becomes an advantage instead of an impediment, since, in every position of the telescope, the eye-piece remains horizontal. The writer has been forcibly reminded of this in prosecuting these surveys with an equatorially mounted silvered glass reflector.

Double and other Stars.

α 0h. 32m. N. 55° 40′, yellow, with a dusky 9 mag. star, some distance, P. not seen with 100, plain with 220, slightly variable from 2 to 2½ mag. in 79·1 days. Birt gives 50·98 days. I have often noticed it of different degrees of brilliancy, but have not observed the period; it is, as Snow observes, more readily obscured by fog than β or even γ, and looks sharper and smaller. Sometimes these three stars are so nearly equal that it is not easy to decide which is the leader. I have often found β brighter than α, and so it is marked on one of Bardin's globes of 21 inches diameter.

β 0h. 2m. N. 58° 26′, 2½ magnitude, creamy, less than 1° S.P. The finder shows a pair of 7 magnitude stars, both of which are doubles. The P. is Struve 3057, magnitudes 9·7, distance 3″ 6°, position 299, yellowish ashy. A neat pair with 150. The other is Struve 3062, magnitudes 6·8, 7·9, distance 1¼″, position 36° 7, epoch 1833. It is an interesting binary of short period (Madler gives 146·83 years, discovered by Sir W. Herschel in 1782, since which time it has completed considerably more than ¾ of a revolution. The closest approach was in 1835, when it had but 0″ 4 of distance, and position 132°·62. In 1865 Knott found distance, 1″·4, position

269°·9. Between these lie a wide pair of blue stars 8½ magnitude, a line through which points out, about 10′ south, a closer and rather fainter pair. About ½° north of β is a pretty triangle, of which Webb appropriately remarks, they suggest actual not optical vicinity; he rates them 8 magnitude, but I find the f. star decidedly the smallest, perhaps 8½ magnitudes, 5′ N. P. β, a neat pair, magnitudes 8·9. 10′ N. another pair, 8½· 9 magnitude, both about 15″ distance. A line from β through the latter pair, prolonged for ½°, meets a pretty pair of equal stars, magnitude 8½, distance 10″, ½°. N. f. a pair, magnitudes 8·9, distance 15″ P. 90° estimated. About 2° N. of β lies a very wide and conspicuous pair, magnitudes about 7·8. The colours are remarkable: red, blue, the larger being a really red star.

γ 0h. 49m. N. 60° 1′ 3rd magnitude, white, in a fine field of minute stars, A few minutes P. lie two wide pairs, 9th magnitude. About ½° S. Ingall has pointed out a pretty pair, red, blue 1865. I found this well seen with 80, magnitude 8·8½, distance 10″ position 180 by an eye estimation. The red of the larger star is plain, but the other seems somewhat obscure, dusky, or dull blue. The pair is P. by a 7 magnitude star. A few minutes f γ lie a neat pair 8½·9, distance 10″, position 70°, by estimation, but just seen with 80. In the same line ½° f γ a pair 8½ magnitude, distance 20″, position 260°, followed by three equidistant stars, reminding one of Orion's belt.

δ 1h. 14m. N. 59°·20, 3rd magnitude, pale greenish with 150. 1° f a little N. lies a pretty group (Messier 103), contained between two bright stars, The P. is 7 magnitude with a faint companion following not more than 10 magnitude. Just seen with 220. The star following the group is about 8 magnitude. ⅓° f. this group a pretty triangle, about 8½ magnitude, very like the one near β, and in same line two pairs, that nearest the triangle 8½·9. Just seen with 100, the other both 9 magnitude f. by a rather brighter, and P. by a much more conspicuous pair, between which and the pair nearest the triangle lies a very faint pair about 10 magnitude. So that within a circle of less than ½° in diameter there are no less than five double stars. Less than ⅓° N.F. δ lies a wide pair 8·9 magnitude, position 240°, estimated, 9 is faint with 80 ¾° N., P. 8 is a fine low power field.

ε 1h. 43m. N. 62° 50′, 3rd magnitude, Greenwich, a shade deeper than δ, with 150 N.F., lie 3 distant 6½ magnitude, stars in a line, between the two nearest ε, a conspicuous pair, about 7½ magnitude, ¾°, following an irregular square of stars, in the centre of which a neat pair, about 8½ magnitude, f star the largest; 1½° N.F. ε is Struve 163, magnitude 6·8, distance 35″, position 33°, 5; golden, ruddy, blue. This is a fine object with 80; the colours which I make red and blue are brilliantly contrasted; ¾° N. of this is 52, a creamy star, with a faint distant companion, S. f and ½° P., this a little cluster with two open pairs.

ζ 0h. 28m. N. 53° 0′, 4th magnitude, white P., at about 20′ distance, by P.O. 114 and 118, magnitude 5·7, about 6′ distance, a pair in finder, very distant in the telescope, both bluish-white, 268 P.O., 1½° S. f, making a triangle with ζ, visible to naked eye, 6th magnitude, a 7th magnitude. N. f, both dull white, a pair in the finder.

η 0h. 41m. N. 57° 8′, a well-known double, mag. 4·7½ binary, with an increasing angle and diminishing distance, as shown by the following measures, selected from the results of many observers;—

P.	D.	Epoch.	Observer.
80°	10″ 8	1819	Struve.
109°	7″ 9	1854	Dawes.
125°	6″ 7	1865	Knott.

There is considerable discordance in the colour estimations of this pair. Smyth, pale white, purple, 1843; South, red and green; Struve, yellow, purple, 1832; Miller, white, dusky, 1851; Webb, yellow, garnet, 1850. I find the colours distinct yellowish and purple, a fine pair, with 220 ι, or P. π 72, 2h. 18m. N. 66° 49′ triple, mag. 4½·7·9, distance 2″ 7½″, position 274°, 107°; 4½ and 7 appear to form a binary pair. Dembowski found P. 265°, D. 1″ 9, 1862; but there is no evidence of motion in the distant star: a fine combination, well seen with 220, pointed out by a line from δ through ϵ, carried rather more than as far again; I found the colour as in Webb, yellowish white, purplish, fine blue.

κ 0h. 26m. N. 62° 13′, 4th magnitude, bright yellow, 1827; white, 1850; a little yellowish, 1855; I find it dull white, 1868. In a beautiful neighbourhood; forms an irregular square with α β γ, about 20′ P., a triple star, components in a straight line, and of equal magnitude, about 8½, all blue; at a rather less distance S. a similar object, components unequal, 8·9·8½, reckoned from N. to S., and closer than the other set. Curiously enough, their lines of direction, if produced, would intersect in κ, and be nearly at right angles to each other.

λ 5th mag., 1° N. P. ζ, bluish white, found double by Otto Struve; Dawes gives D. 0″ 5, P. 116, epoch 1854; not even elongated in the reflector, ½° S., a 7½ magnitude, star, f. which lies a wide pair 8·9 magnitude, P. 300″. Estimated.

ρ (Struve, 3049), 23h. 52m. N. 52° 2′, magnitude 6·8, distance 3″, position 323°, flushed white, small blue, 3½° S. of β, a little F, well seen and colours fine with 220; this pair discovered by Sir W. Herschel in 1780, makes, with 237 P., 6 mag., and 236 P., 7 magnitude, a large triangle in the finder. Between ρ and 237 lie two very wide pairs, the closest nearest ρ, 6′ S. of which a neat 10 magnitude pair P. by an 8 magnitude star in same line, making a triple object. Just visible with 100, well seen with 220.

τ 5° P. β, 5 magnitude, light yellow, S.P. this, an 8½ magnitude pair, distance 40″, estimated, ½° N.E., a 6 magnitude greenish star, ½°, P.S. which are a neat pair, 8½·9, distance 30″, also an estimation.

υ^1 6 magnitude, yellow and υ^2, 5 magnitude, light yellow, a pair of stars, visible to the naked eye, between γ and η, ½° N. of υ^2, neat pair 8¼ magnitude, D. 15″, P. 200, 1° S. of υ^1; a pair of similar magnitude and distance, but P. 60, both mere estimations; they lie between two distant 8 magnitude stars.

φ 1h. 12m. N. 57° 31′, 5 magnitude, is attended by a beautiful group. Herschel VII., 42, well seen with 100; two pretty triangles and a neat pair will be at once noticed: φ has a bright star a few minutes P. Position 227·5, from measures in 1867.

ψ (Struve 117), 1h. 17m. N. 67° 27′, magnitude 4½·9, distance 32″, position 102°. 1836, Smyth; probably binary, since Dembowski found D. 29″· 7, P. 105, 1865; the companion is again double, 8·9, 9½, D. 2″ P. 252°, 1836, Smyth; D. 3″, P. 253°, 1831, Struve; D. 2″ 8, P. 255°, 1865, Dembowski. Undoubtedly binary, forming a fine ternary system. Smyth gives the colours yellowish ashy; but I should call the small stars blue. Well seen with 220, the P. star of the close pair, the larger 1868, it forms the apex of a triangle with ϵ and ι when the constellation is east of the Pole star.

7 2° N. of ρ, 5 magnitude, yellow, f, by 232, P. XXIII., 6 magnitude, decided green.

100, 101, P. XXIII., 10′ P. β, 23h. 24m., N. 57° 50′, magnitude 5·7½, distance 74″, Smyth. Light yellow, white, 1830; pale white, yellowish, 1852; Webb makes 7½, pale lilac, 1854; Grover white, bluish, 1868;

Dawes has doubled 7½ again; distance 1½″, position 322, 1840. No trace of this in my telescope. Webb says a 14 magnitude, lies at distance 20″, and position 345°; from this I found it a conspicuous object with any power, certainly not less than 10 magnitude, and a neat pair, following which Webb makes 10 magnitude. I find considerably unequal, perhaps 8½·9½, the latter faint with 100, 220 showed it well.

Struve 3053, 23h. 56m. N. 65° 23′, magnitude 6·7, D. 15″, P. 70, pointed at by a line from γ to κ, carried rather more than as far again, a fine object with 80; colours beautiful, fine yellow, fine blue, 1868.

36, 2h. 24m. N. 72° 0m., 6 magnitude, has a wide 8 magnitude S. pair N.P.

Clusters.

392 (♅ VI., 31), 1h. 37m. N. 60° 35′. Coarse cluster, ½ S. wide, 8½ magnitude, pair. North of this a very faint pair, perhaps 9½ magnitude, about 6 minutes P. this a 9 magnitude pair, the angle of position of these three pairs not greatly differing, 90° or 270; more than ½° N. of the cluster a neat pair about 8 magnitude, distance 10″, estimated, a real pair so exactly alike as to suggest physical connection.

341 (M. 103), 1h. 25m. N. 60° 1′. See under the head of δ, not marked on the maps of the Society for Promoting Useful Knowledge.

120 (♅ VIII., 78), 0h. 3m. N. 61° 5′. Coarse cluster, rudely resembling the letter W, numerous stars preceding, but a singularly blank space on following side, except a neat 8½ pair, and one or two small stars half-way from γ to κ; well seen with 80.

5031 (♅ VI., 30), 23h. 51m. N. 56° 0′. Large cloud of faint stars. Sir John Herschel says 11 to 18 magnitude; those I see are from 9 to 12; fills the field with 100, a very fine object between ρ and 7, but nearer the latter.

[Our readers will, we are sure, be much indebted to Mr. Grover for his careful observations of this constellation; but at the same time, the number of contractions in his MS. render it difficult to avoid errors in printing.—Editor.]

CORRESPONDENCE.

THE MOON: ITS MOTION AND PHYSICAL CONSTITUTION EXAMINED.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Those who have read my letters on Comets will be better able to follow me in the following papers, and will be somewhat prepared for the conclusions at which I arrive. But as some may examine this theory who have not read them, I shall endeavour to write so as to explain my meaning, and hope your readers will exercise sufficient patience to finish my letters, when, if they see my meaning, I shall not fear but that they will discard the old theory and embrace the new. I am fully aware that difficulties must be encountered. Some may smile when I state my firm conviction that astronomers are wrong in teaching the "moon revolves on an axis passing through its body in addition to its revolution round the earth, or, more correctly, round the centre of gravity between the earth and moon." Yet this teaching is certainly an error, and it keeps important truth out of sight. I met with the statement several years ago that the "moon does not revolve on an axis of its own," and at that time I wondered at the ignorance of the man who knew no better; and years ago, when my friend Mr. Winder said to me, "The books teach that the moon revolves on an axis of its own, but I do not believe it," I thought, almost audibly, you have studied astronomy to but little purpose. They were right, however, I was wrong; and I think it can be shown that the moon's motion round the earth, without an axial motion, will explain all lunar phenomena, whilst the received teaching will not.

But before we enter on the investigation of the moon's motion, let us try to understand each other in reference to the motion of bodies in general, especially bodies of a circular form.

Let me state the following propositions, which I hope will be made clear to all.

1st. A body may have no revolution at all.

2nd. A body may revolve on its own axis. This a wheel does when in motion around a stationary axis; every part of the circumference, or rim, is carried round the axle at the centre. It is evident that the wheel has one motion, and only one, viz. a rotatory motion on its axis.

But it is also clear that other wheels may be attached to the rim of this wheel, and they may be so attached as to have no motion, except the one they have in common with the wheel to which they are fastened; or they may have an additional motion around an axis passing through themselves. In the latter case they will have two motions—one around their own axis, the other around the axis of the larger wheel to which they are attached.

Let me try to make the same truth clear by another illustration. Suppose I were to take my stand on the turn-table of a locomotive engine, with my face looking eastward. Now, though the turn-table may not be in motion, yet, by turning myself round on my feet, I can bring my face toward the south, west, north, and back again to the east, making the entire circle by *turning myself*, or by revolving on my own axis.

But it is equally clear that I might remain stationary myself, and the *turn-table* might be put in motion. Now, as I stand at its edge or near it, I shall be carried round on it, and by partaking of *its* motion my face will be brought opposite the different cardinal points in succession. This is not because I turn on *my own axis*, for I do not, but because I am carried round *the axis of the turn-table* on which I stand.

It will be also possible that, whilst I am being carried round on the turn-table, I may at the same time turn round myself. In this case there will be two motions, one round the axis of the turn-table, the other round an axis passing through my own body: *in this case* I have two motions, *in the other cases* I have only one.

Now it is clear that in any of those cases my face would turn toward every point of the compass in succession. How then can we know which of the causes—the motion round my own axis, the motion round the axis of the table, or both combined, produces this result?

One fact will show us. In the second supposed case I shall not change in reference to the centre of the turn-table. If I get on on the west side and look across the table toward the east, I shall have the centre of the table before me; and though my face turns in succession toward every point of the compass, it will also always look toward the table's centre.

This proves two things: 1st. That I do not revolve on an axis passing through myself. 2nd. That I revolve round the centre of the table on which I stand.

Hoping that the motions referred to are understood, we will now apply this mode of investigation to the motions of the moon.

We notice first that the moon does certainly revolve around the earth. Nothing can be clearer than this. An observer placed on the earth sees it pass through all the signs of the zodiac every lunar month, which appearance could only be produced by it revolving round the earth, or the earth revolving round it; and as smaller bodies revolve round the larger, and not the larger round the smaller, the moon must revolve round the earth.

2nd. The question now presents itself—"Has the moon an additional motion round *its own axis*?" and this question can be answered with a certainty which admits of no mistake. In our illustration of the turn-table it is clear that, if the man turns on his feet, or on an axis passing through himself, he will present his face to the different points of the compass in regular succession. He will turn his face toward and from the centre of motion (or of the turn-table) with equal regularity; and an observer placed at the centre of that table will see his back, shoulders, front, and back again. But in case the man stepped on the table with his face toward its centre, and then remained stationary, though the table be set in motion, and as a consequence his face is turned toward the different points of the compass, his face will be always looking toward the centre of the table; and an observer standing at that centre and looking at the man, must always see his face.

In the case of the moon, its motion round the earth as a centre is known to exist, and as an observer placed at that centre, or on the earth, always sees the same face of the moon, a second motion round the *moon's own axis cannot exist.*

Believing this point to be established, let us trace the consequences which must result from the moon moving round the earth, without having a rotatory motion on its axis.

1st. If the moon were ever in a gaseous, fluid or plastic state (as from the flattening of the primary planets at their poles they appear to have been); so that the particles would be free to move, the lengthening out of the moon's body will have been the result. If we suppose the point of the moon nearest the earth to move at any given rate, the point farthest from the earth must move faster, for it passes round the earth in the same time as the inside point, and the semi-diameter of its orbit is larger by the diameter of the moon itself. But, moving in a larger orbit, its tendency would be to move slower than the inner point (as Kepler's laws clearly prove), and it would fall back in its orbit if its connection with the inside point were severed. These forces—the inside tendency to go faster, and the outer one to go slower—will have lengthened the mass, and given it something of the form of an egg, having its longer axis pointing toward the earth. Supposing the moon to be globular in form, the centre of gravity will not be at the supposed centre of figure, but back at a greater distance from the earth than that point. The centre of gravity must be sought for at the centre of an ellipse and not at the centre of a sphere. This is now known to be the fact, although when I first reasoned thus it had never been heard of, at least by me. The first result, then, for which we naturally look is in accordance with fact, and explains the cause of the moon's figure or shape, which is not explained by any other theory; but that the centre of gravity does not exist at the centre of the sphere, Hansen's investigations prove.

The second conclusion to which we are led is this:—*All matter on the moon's surface which is free to move will be thrown to the side of the moon farthest from the centre around which it revolves by centrifugal force.*

The same forces which, by acting on the body of the moon, have given it its elongated figure, must have acted on the most yielding matter, as liquids, fluids, &c., to carry them backward to the remoter part of that body. Water, air, &c., need not be looked for on the side of the moon next to us; if it exists there at all, it must be on the side of the moon which we are doomed never to see; but it is possible that all the atmosphere may be already dispersed in space, for, like the tails of comets, all yielding lunar matter must be undergoing the process of constant elongation, until it be finally scattered, to be collected by the moon no more.

I need not say to your readers, that accords with the facts of the case so far as we know them. Here, again, theory and fact coincide.

Perhaps this may give us a glimpse at the possible constitution of the lunar surface on the side turned toward us. We are aware of the fact that heat on the earth has some connection with the amount or density of our atmosphere; the tops of mountains in the torrid zone are capped with eternal snow, and their sides form one continued glacier; and there can be no doubt that if the terrestrial atmosphere were removed gradually, until its density at the earth's surface should be no greater than it is on the mountain tops, the vapours, in consequence of a decrease of heat, would gradually condense and deposit themselves in snow and ice on the earth's surface; and should the process continue until the atmosphere were altogether removed, the oceans themselves would be converted into large expanses of solid ice.

Now, if the moon was at one time a hot and plastic body, enveloped by a dense atmosphere charged with vapour, the gradual withdrawing of the atmosphere by centrifugal force (the necessary result of the moon's motion) would cause a diminution of heat, and the result would be the condensation of the vapours, which would flow in rivers to the lower parts, forming meres or seas, and capping the mountains with ice and snow, which would continue to pass downward until the seas were converted into a solid mass, and the whole lunar surface be covered with glare ice. This seems to be the inevitable consequence of the removal of the atmosphere; and it is even possible that those enigmas, the rays from Tycho and other mountains, may have some connection with this state of the lunar surface.

Thus far, in speaking of the moon's motion, we have supposed its orbit to be circular, with the earth in the centre of the orbit; but in reality this is not strictly true: the moon moves in an ellipse, and the earth is situated in one of the foci of that ellipse. It follows that the moon must be nearer the earth at some parts of its orbit than at others. During its passage through one half of its orbit it will approach the earth, and through the other half it will recede from it.

We have also stated that the moon's longer axis points towards the earth: this is not always strictly true either; the line of the apsides of the moon's figure, if extended to the earth, would oscillate somewhat, or move round the earth's centre, from the following cause:—

We have seen the moon to be, not a sphere, but an elongated or egg-shaped body; let us trace the motion of this body in its orbit as it approaches the earth, or from its apogee to its perigee.

The earth's attraction is the force by which the moon is moved in its orbit when approaching the earth, or from its apogee to its perigee: and after passing its perigee, it is carried off from the earth by its projectile or centrifugal force, attraction moving it towards, and momentum carrying it out from, the earth. Now, as the earth attracts the moon's inner point stronger than it does the outer or more distant points, the inner point will be drawn on more rapidly than the outer one, which will fall back gradually as it approaches the earth, showing a little more of one side and less of the other than it would do but for the falling back of the outer part, in consequence of its moving in a larger orbit, and at a slower pace, than the part of the moon nearest the earth.

But as soon as the moon passes its perihelion the earth's attraction acts on the moon to retard its motion, and as the inner part is more strongly attracted than the outside part, it is retarded more rapidly than the outer part is. The outer part has been drawn on by the earth more rapidly than it would have been, in consequence of its connection with the inner part of the moon, and has acquired a greater momentum than the inner part has or possesses—this carries it onward rapidly after it passes perihelion; and the fact that the outer part is less retarded by the earth's attraction than the inner part, on account of its greater distance, gives it an increased advantage over the inner part, so that it gains on it; and not only gains what it lost in its approach to the earth, but moves in advance; thus showing as much *more* of the opposite side as it had shown *less* in its approach. This is the true cause of the moon's libration in longitude, and not a revolution round an imaginary axis, which has no existence in fact.

To understand the cause of the moon's libration in latitude, it is needful to bear in mind the fact that the moon is *not a sphere*, but of a spheroidal figure, in shape resembling an egg, having its longer axis turned toward the earth. It is also to be observed that the plane of the *moon's orbit* does not coincide with the plane of the *earth's orbit* but crosses it an angle of about 5°; thus the moon is above the plane of the ecliptic during half its revolution, and below it during the other half. The moon's longer axis would point invariably and directly toward the earth were it acted on by the earth's attraction only; but the *sun* also acts on the moon, and but for the earth's greater attraction would cause its longer axis to point towards itself (viz. the sun). The sun's attraction has a tendency to bring the moon's longer axis to coincide with the plane of the ecliptic, whilst the tendency of the earth's attraction is to throw that axis at an angle of 5° from that plane. In fact, the end of the moon nearest the sun will be drawn upward by the sun's attraction when the moon is below the plane of the ecliptic, and downward when it is above that plane, thus showing more of its northern side at one time, and of the southern side at another. This is the cause of libration in latitude and not the inclination of an axis of rotation, which we have shown does not exist.

There is one point more to which I shall call attention, and then for the present I shall have done.

If the moon has lost some of the matter of which it was originally composed it must now move in a smaller orbit than once it did, and consequently at a more rapid rate than it did before that matter was lost; and if this process still continues, its orbit must be still contracting, and its periodic time diminishing. Is it not possible that the accelerating rate of motion referred to by Mr. A. Herschel in the *Register*, in his letters on the moon, may in part be due to this cause?

I am, Sir, with much respect, truly yours,

Toronto: Dec. 20, 1869. A. ELVINS.

P.S.—I was glad to see Mr. Perigal's excellent illustration and demonstration of lunar motion in the number for March last.

The Astronomical Register is intended to appear at the commencement of each month; the Subscription (including Postage) is fixed at **Three Shillings** per Quarter, *payable in advance*, by postage stamps or otherwise.

The pages of the *Astronomical Register* are open to all suitable communications. Letters, Articles for insertion, &c., must be sent to the Editor, Mr. S. Gorton, *Parnham House, Pembury Road, Clapton, N.E.*, **not later than the 15th of the month.**